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JOURNAL OF GENETIC PSYCHOLOGY

Child Behavior, Animal Behavior, and Comparative Psychology

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The Journal of Genetic Psychology, 1949, 74, 3-16.

PROPERTIES OF BI-DIRECTIONAL GRADIENTS AT SUBGOALS*[1]

Department of Psychology, University of New Hampshire

GEORGE M. HASLERUD[2]

The problem grew out of the generalizing tendency of the goal gradient (2) A prescribed turn to one side next to the goal in an otherwise free maze has an anticipative effect which extends backward toward the starting unit as a convex exponential curve. The entrance gradient, however, is concave in form and generalizes very little. The question then arises are the gradients preceding and following a subgoal like the respective goal and entrance gradients of the whole maze?

Hull (4), in his *Principles of Behavior*, stated the physiological and psychological similarity of subgoals and end goals Thorndike (8), in the course of studies on the law of effect, found gradients on either side of a rewarded response, manifested by tendencies to repeat previous responses for these positions whether correct or not. To test the Thorndike effect Muenzinger (6) arranged four lengths of a five-unit multi-valve maze in the form of a square with feeding box at each corner In a trial of six circuits of this endless maze preceding and following the goals (really subgoals), the errors increased with distance from the food, making the bi-directional gradient which he contended verified the Thorndike proposal Thompson and Dove (7) repeated the Muenzinger experiment with a 7-unit 7-valve double-straightaway maze and came to the same conclusion. Hill (3) claimed, however, that the difficulty of eliminating the anticipatory errors in the middle of a maze made the apparent gradients Hill's experiment, it should be noted, had the conventional one goal, while Muenzinger's had in the endless maze actually a succession of subgoals If the bi-directional gradients could be shown in a non-error situation, then obviously Hill's criticism would not apply; that was done by Jenkins (5). He had a 20-unit free maze in which the various groups of rats received a morsel of food at different locations along the maze pathway. For the first five massed trials there was a gradient from each side of the food, more pronounced preceding

---

*Received in the Editorial Office on February 2, 1948

[1] Extensive revision of report given at the Philadelphia meeting of the A P A, September 4, 1946

[2] This experiment is part of a program of research on transfer The University of New Hampshire made a special grant to establish the study

than following it, but on the second half of the 10 trials the tendency of the rats to go predominantly to one side or the other made the gradients flat Also with massed trials the motivation of his rats was insufficient, even with much preliminary training

Our objective, then, was to get as dynamically sensitive an indicator as Jenkins had but one much more stable By setting up a tendency to go to one side through forced turns in the beginning and goal units and at the same time putting one or more culs-de-sac on that side next the subgoal, the resulting adjustment in the remaining free units is a figure of contrary turns against the ground of the common sidedness The problem of getting just enough sidedness to act as a standard reference level but not too much (the consequences of which are shown in Figure 4) was solved by a delay of 10 seconds before placement in feeding cages. This delay relatively isolates and accentuates the subgoal effects[3]

A. Apparatus and Procedures

The apparatus described in (2), improved in uniformity, interchangeability, and control, is shown in Figure I Each unit consists of a 2" pathway around the perimeter of an open triangle of base 18" and altitude 13¼" with a straightaway of 4" attached to the apex, all this cut from a single piece of 5-ply plywood ½" thick This unit is attached by a strong hinge to a stand 30" high. To connect one unit to another a two-prong angle-iron attached to the end of the 4" straightaway slides over a fixed bolt near the stop of the stand and fastens easily with a wing nut. The unit is made non-Retraceable and is provided with culs-de-sac by a V-shaped light galvanized iron block 13" x 18" saddling the converging paths 5" from the union With 3" of the 13" height below the maze level, the rats are neither able to climb under nor over the barrier, and the "ears" made by bending back the iron below the doors permit a strong fastening by wing bolt to the maze unit. Doors slightly larger than the 2½" square openings swing from the back, and either one can be locked by a sliding pin to make that side a cul-de-sac. The stability of this elevated rectilinear maze and the quick interchangeability of units gives the flexibility needed for a wide variety of problems

Twelve units were arranged in the midline length of a long, narrow

---

[3] DeMontpellier (1, p 131) proposed that delaying the goal food for two hours changed the location of the goal gradient It was as though the goal had been pushed far beyond the maze in space as well as time Our results in the present experiment indicate that even a very short delay will significantly displace the goal gradient

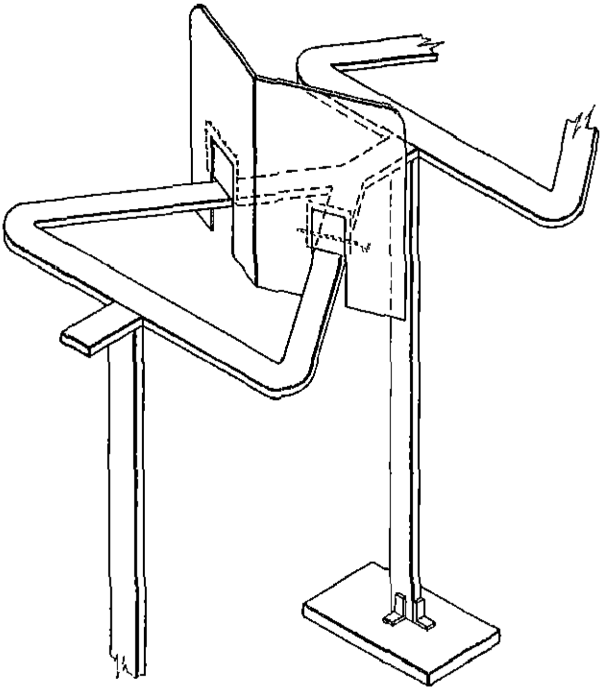

FIGURE 1
ELEVATED MAZE UNIT ADAPTED FROM THE HERON-DRAKE MAZE PATTERN

room, with the start at the windows at one end of the room. Individual food cages were placed directly ahead of the goal to do away with any possible goal orientation to one side or the other except for the last turn before food. The apparatus was painted black to show up well the white rats.

The subgoal of 0.1 gr. of slightly moistened chick mash was placed in a small metal container painted black, the base of which fitted snugly over the sides of the maze pathway. It was always placed at the mid-point of the 4″ connection between Units 6 and 7, the exact middle of the maze. At the end of the maze after a delay of 10 seconds the animal was lifted forward to the individual feeding cage where it could eat for 15 minutes to allow for growth in the rats 40 to 60 days old at the beginning of the experiment.

After a week of preliminary training on an 8′ straightaway to accustom the rats to elevated path, doors, and food rhythm, 20 trials were given at the rate of one a day. Between the first and last 10 trials there was a rest of one week.

A separate group of 12 naive rats was used for each of the six sub problems Half of the rats had an enforced sidedness to the right, and half had it to the left. By having culs to the same side at only Units 1 and 12, the free units from 2 to 11 also tend to exhibit the position habit. On the path of this position habit (by blocking on the side opposite that which had culs at 1 and 12) one or more blind-alleys were placed next to the subgoal according to the following arrangement:

Group I block at 6 just before the subgoal
Group II block at 7 just after the subgoal.
Group III block at 6 and 7 with subgoal between
Group IV block at 6 and 7 with no subgoal.
Group V block at 6 and 7 with no subgoal but with hardware cloth ladder between
Group VI entirely free maze; food subgoal between 6 and 7

Groups were run in the same order each day, but within the group the order was varied.

B. Results

The three parts of Figure 2 portray the effects of blocking around the subgoal food. The unit blocked is indicated by a vertical line It should be remembered that Units 2 through 5 and 8 through 11 are free in all cases and that in the first two parts of the figure Units 7 and 6 are also free respectively. The curves are the percentage of turns to the same side as prescribed at the subgoal For example, when 6 is blocked, an entry into a cul at 6 would count against while an error at 12 would mean, of course, a turn to the same side as prescribed at 6, the free units are unequivocal The dotted lines varying close to 50 per cent or chance are for the first five trials.[4] The solid lines are for the last five trials, Trials 16 to 20 There is a steady change through the groups of five trials to this level. That it probably represents a fairly stable equilibrium of the subgoal figure to the

---

[4] Particularly on the first five trials there was a real difference between those rats which had a right sidedness based on turns at units one and twelve and those with a left sidedness. The near fixation on the right side for both groups was probably due to the location of racks of living cages on the right side of the room. When this was corrected by placing the living cages at the end of the maze, the discrepancy between the groups disappeared Since the effect was present for all placements of prescribed turns around the subgoal and since the balancing of each group for right and left turns compensated for the tendency, the various curves should be relatively the same as if the difficulty had not occurred Table 1 shows that the progressive change from one set of five trials to another is quite smooth and consistent

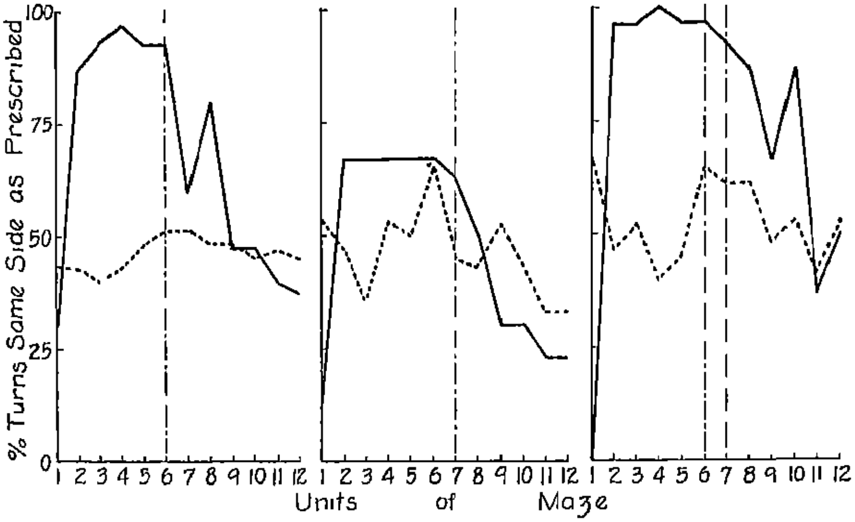

FIGURE 2
Comparison of First Five Trials (Dotted) With Last Five Trials (Continuous) for Blockings of Sidedness Before (Unit 6), After (Unit 7), and Before and After (Units 6 and 7) Subgoal Food

sidedness ground is suggested by the small difference between curves for the previous five trials, 11-15, and those shown here. Table 1 will show this for the raw data.

Whether the blockage precedes or follows the subgoal makes a great deal of difference. When Unit 6 is blocked, just before the 0.1 gr. subgoal food, a very strong tendency occurs, over 90 per cent, to anticipate that prescribed turn in the free units from 2 through 5. Unit 1, it should be remembered, is prescribed to the other side, as is Unit 12. There is some perseverative effect for two units *after* the subgoal too, but both the level and the number of units involved are much less than that which precedes the subgoal blocking. When the blocking is at Unit 7, on the other hand, the small effects are entirely in the units preceding the subgoal. The perseverative effects are hardly different from the chance curves of the first five trials. Most peculiarly there is not even a significant tendency except for Trials 6-10 to make a correct turn at 7 after eating the subgoal food.

Although blocking the unit right after the subgoal by itself has little or no effect on the other units, apparently when both 6 and 7, preceding and following the subgoal, are blocked to the same side, an accentuation of the perseverative reaction occurs, about twice as much as when 6 is alone. The

TABLE 1

NUMBER OF TURNS TO THE SAME SIDE AS PRESCRIBED RESPECTIVELY AT 6, 7, OR 6 AND 7 IN 5-TRIAL GROUPS*

N	Total turns	Trials	Units of maze 1	2	3	4	5	6	7	8	9	10	11	12
							Block 6							
12	60	1- 5	26	25	24	26	28	51	31	29	29	27	28	27
12	60	6-10	10	36	41	40	37	44	26	24	29	24	16	17
6	30	11-15	8	27	27	29	26	28	23	23	23	14	14	9
6	30	16-20	9	26	28	29	28	28	18	24	14	14	12	11
							No delay at end**							
6	30	11-15	6	15	21	17	21	25	10	10	4	8	8	5
6	30	16-20	5	16	24	22	21	29	4	5	3	5	6	5
							Block 7							
12	60	1- 5	32	28	22	32	30	39	27	26	31	26	20	20
12	60	6-10	11	38	41	44	43	35	43	35	23	21	16	25
6	30	11-15	1	22	20	20	20	19	16	16	11	6	7	6
6	30	16-20	4	20	20	20	20	20	19	15	9	9	7	7
							No delay at end							
6	30	11-15	0	16	17	20	19	17	16	12	0	5	2	13
6	30	16-20	1	17	15	15	15	13	14	8	6	3	2	4
							Blocks 6 and 7 subgoal							
12	60	1- 5	40	28	31	24	27	39	37	37	29	32	25	32
12	60	6-10	21	45	48	46	49	53	52	46	41	43	31	29
6	30	11-15	9	29	30	30	28	27	25	29	25	29	20	12
6	30	16-20	0	29	29	30	29	29	28	26	20	26	11	15
							No delay at end							
6	30	11-15	5	22	26	28	25	28	25	9	7	9	5	3
6	30	16-20	2	24	28	29	29	28	25	2	4	2	0	0

TABLE 1 (*continued*)

N	Total turns	Trials	1	2	3	4	5	6	7.	8	9	10	11	12
			Blocks 6 and 7 ladder but no food subgoal											
12	*60*	1- 5	46	28	31	31	24	33	30	27	26	29	25	24
12	*60*	6-10	18	26	25	35	35	*43*	*51*	28	18	22	17	16
6	*30*	11-15	*7*	17	9	16	*23*	*25*	*29*	9	*7*	*7*	13	*3*
6	*30*	16-20	*3*	20	11	21	*27*	*28*	*30*	12	10	9	10	*4*
			No delay at end											
6	*30*	11-15	9	10	18	17	19	21	*30*	15	9	*6*	*6*	*6*
6	*30*	16-20	*3*	*6*	13	12	18	18	*30*	11	*4*	*1*	*1*	*1*
			Blocks 6 and 7 no food											
12	*60*	1- 5	31	32	23	27	27	24	28	25	22	28	22	31
12	*60*	6-10	*7*	37	30	34	27	22	33	26	19	21	19	25
6	*30*	11-15	*0*	18	12	15	15	15	12	12	13	8	10	12
6	*30*	16-20	*1*	14	16	20	21	12	17	16	11	10	9	13
6	*30*	30-35	10	22	9	19	8	17	13	13	10	8	*6*	*7*
6	*30*	36-40	*0*	18	10	16	11	15	11	9	9	*4*	*5*	*5*
			Blocks 6 and 7 subgoal food											
6	*30*	11-15	*5*	21	15	14	14	12	15	10	11	8	*7*	*6*
6	*30*	16-20	*7*	17	17	21	22	19	15	11	10	11	*6*	9
6	*30*	30-35	*2*	*25*	*24*	*27*	21	*27*	*27*	17	21	12	*7*	10
6	*30*	36-40	*3*	*26*	*24*	*28*	*29*	*29*	*23*	8	17	*7*	*9*	*7*

*Italicization of those numbers of turns significantly higher than or lower than chance

**Units 1 and 12 both blocked to side *opposite* that at middle, all other units free Hence 1 and 12 and neighboring units are apt to have significantly *less* than chance similarity to prescribed turns at the middle pre-subgoal effects are increased slightly to the limiting 100 per cent from their high value with 6 alone. From these three groups of rats one should have to conclude that any prescribed turn before a subgoal has much more tendency to generalize to preceding units than does one after the food perseverate. Only when the subgoal is merged into the problem, as in the 6-7 blocking, do we get increased generalization, including forward effect, although it still remains less than effects preceding the subgoal.

Figure 3 gives the results of two groups which were run with the blockings at 6 and 7 but with no subgoal food, as compared with the group already mentioned which had subgoal food. When no food is present, the rats neither learn the culs at 6 and 7 nor generalize the turns to free units. The curve is very much like the chance curve of the first five trials except for the learning of turn at Unit 1. These contrasting curves show the difference that 0.1 gr of food can make when placed as a subgoal. Table 1 shows that even in 40 trials there was no learning or generalization. For half of this group given subgoal food after Trial 10, fully 20 trials were required before the anticipations of blocked units appeared. By Trial 40 the perseverations were still not present. Perhaps the absence of subgoal

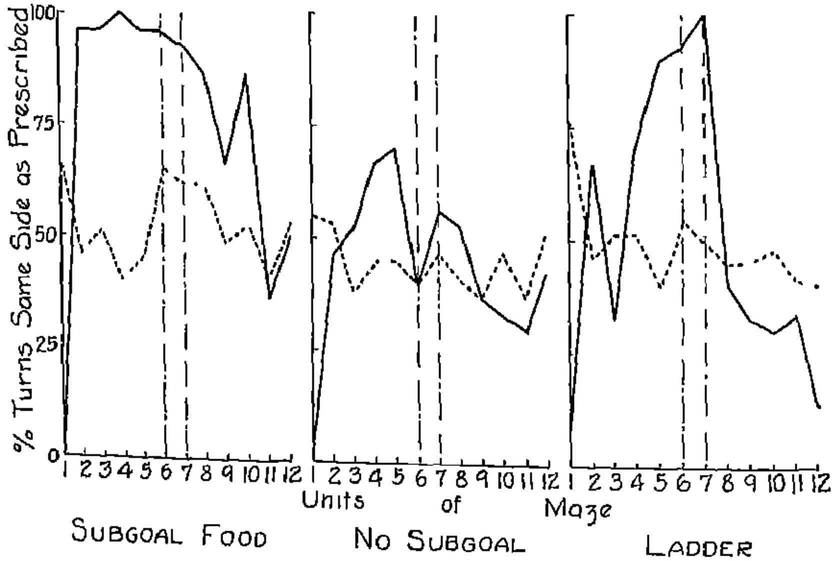

FIGURE 3

Comparison of First Five Trials (Dotted) With Last Five Trials (Continuous) for Blockings at 6-7 With Subgoal Food, No Food, and No Food But a Ladder between the Blockings Respectively made for fixation upon the sidedness of last turn even though there was a delay of 10 seconds.

The third part of Figure 3 gives the rather surprising finding that while the group got no subgoal food, the going up, over, and down a hardware cloth double ladder 5½ inches high, inclined at an angle of 75° to the pathway, like a stile, makes for learning of the adjustment required at 6 and 7 and also definite anticipation at Unit 5 and possibly 4 too. The perseverative effect following 7 is definitely lacking, varying around the chance level. It appears that subgoal food is necessary for generalization forward, although anticipation of turns may occur without it.

In Figure 4 the solid lines are results for the last five trials already presented—block at 6, block at 7, block at 6 and 7, and block at 6 and 7 with no food but with the kinesthetic cue of a ladder. The heavy dashes give the results for that half of each group which after the 10th trial was given a large dish of food at the end of the maze instead of the 10-second delay of the solid line groups. The immediate food obviously strengthens the sidedness produced by the anticipation of last turn before food. The curves for Units 8 through 11 are almost identically low in their relation to the prescribed turns around the subgoal. But while the perseverative effects are overwhelmed by the immediate end goal, the curves for units preceding the subgoal are only lowered slightly and keep their essential form and relative magnitude. The maze becomes a double problem divided

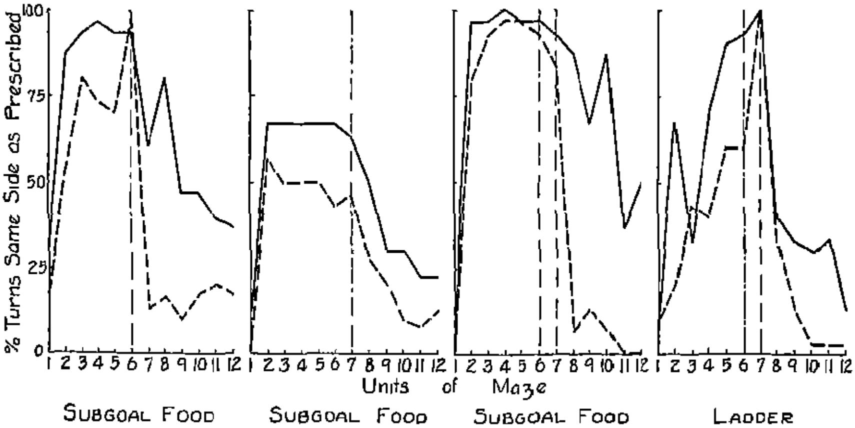

FIGURE 4

Comparison of Blockings on Last Five Trials for Groups With 10-Second Delay at End Goal (Continuous) as Contrasted With Groups With Immediate End Goal (Dashes) from those of the ordinary start-to-goal that it is obvious how mistaken Hill (3) was when he analyzed the problem as though four mazes just happened to be connected around a square and could be checked by a maze with four units and a single goal. The start-to-start situation will occur only where there are subgoals. Hill's picking up the rat and rapidly transferring back to the beginning apparently did not give the end goal this subgoal character until after 20 trials Thompson and Dove (7) suggest that the difference may be primarily that between massed and distributed trials. However, the present experiment would point to the characteristics of subgoals. A subgoal differs from an end goal in that time and spatial arrangement allows the weak perseverative effect of the pre-subgoal gradient to amplify or reinforce the meagre starting gradient in the post-subgoal region.

Just as in our Group III Muenzinger had his food subgoals merged into the problem. Because the action required at the unit preceding and that following the corner are not the same, however, the apparent post-goal effect would be somewhat reduced. Also the kinesthetic cue of the 90° turn at the corner would have most of its influence on the pre-food units rather than on those which follow, if the results on our Group V can be generalized These perseverative reactions onward from the subgoal rapidly built up conflicts with the anticipatory movements preceding the next subgoal of the square Hill (3) believed that anticipation made the difficulty in the middle of his maze. The considerably higher number of errors in the start-to-start (subgoal) than in the start-to-goal situation for the middle of the maze for both Muenzinger (6) and Thompson and Dove (7) points to a conflict as the source of the difficulty.

The symmetry of the curves in the preceding experiments (6, 7) most errors at the middle and rather constant slope toward fewest errors at the first and last units, might suggest that the post-subgoal and pre-subgoal effects are rather evenly matched The results of the present experiment and also a previous one (Haslerud, 2), would indicate, however, that the five- and seven-unit mazes of Muenzinger and Thompson and Dove respectively would represent just about the greatest length in which symmetry of curves would be secured With longer mazes, the weakness of the perseverative tendency to influence much beyond the fourth or fifth units would become apparent. One needs only look at Figure 4 to see that the pre subgoal anticipatory tendencies are much the stronger. A good test of the present contentions about subgoals would be to run animals in a 12- or 14-unit start-to-start maze of the Thompson and Dove arrangement

(7) If the curve of errors was unsymmetrical, with the point of greatest errors per unit one or more units toward the starting point from the middle, it would substantiate our conclusion that the post-subgoal effect is present but relatively weak A theory of transfer of training needs to take that weakness into consideration.

D SUMMARY AND CONCLUSIONS

1 Seventy-two rats, divided into six groups, demonstrated pre- and post-subgoal gradients against the ground of enforced sidedness by their *adjustment to a contrary cul-de-sac preceding, following, or both preceding* and following subgoal food at the middle of a 12-unit rectilinear, elevated maze Delaying the food 10 seconds at the final goal is an important part of the technique for showing subgoal effects

2 The entire maze becomes organized into gradients; in the first one or two units is the small starting gradient, and in the remainder in varying degree is the goal gradient Subordinate organizations may occur within the total field because of subgoal food or some distinctive landmark (as the ladder in Group V)

3 The pre-subgoal gradient or curve of anticipatory effects has the convex shape and exhibits the power of the end goal gradient As Hull postulated, the gradient preceding a subgoal is indistinguishable from that preceding the goal

4 The post-subgoal gradient is fundamentally a steep concave curve like the entrance gradient at the start of any rectilinear maze, but it shows in addition a perseverative factor which might for wider generality be called a post-subgoal effect, this may maintain a high performance in the units just following the subgoal before the steep decline occurs If there is no food but only a distinctive kinesthetic cue as in Group V, only the fundamental concave curve is present. *If food is the subgoal, the exhibition of the* perseverative factor seems to depend jointly on the weakness of the end-goal effect and on whether the pre-subgoal conditionings are reinforced or attenuated by the required acts following the subgoal Group III, where the turn preceding the subgoal was the same as that following it, showed the maximal post-subgoal effect The extension forward of prescribed turns next to the subgoal is particularly dependent on the strength of interfering end goal organization.

5. In the practical situation the subgoal does divide the maze into parts The unit after the subgoal is much like the beginning of a new maze. The

post-subgoal effect is attenuated by interfering factors in the usual error situation of the maze.

6. The implications of this experiment for the problem of increasing transfer of training are very suggestive.

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AN EXPLORATORY STUDY OF COLOR DISCRIMINATION OF CHILDREN*

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D L SYNOLDS AND N H PRONKO

Is color perception native? Is each individual born with a certain "capacity" or "incapacity" for discriminating colors, or are these reactions built up during the person's psychological history in the same manner as his touch or taste perceptions?

An exploratory study by the authors throws some light upon this general problem and has opened up an interesting area for further investigation The present paper is a preliminary report

A PROCEDURE

Seventy-four children, ages 3-8, including 38 males and 36 females, served as subjects These were selected at random from the school population of Washington and the Wichita Day Nursery

As test materials, the investigators used the Dvorine Color Perception Testing Charts but since it was felt that employment of all 60 plates would make undue demands upon the children, particularly in the younger age groups, it was decided to use only the charts on the left hand side. The *rotating color disks were used for the color-naming part of the study*

Each child was taken into the experimental room singly and, after rapport was established, he was introduced to the rotating color disks and asked to name the eight dark hues presented one at a time Presentation of the color charts followed after the subject was shown the easily discriminated Chart No. 1 The *E* outlined the figured 48, with a paint brush, turned the manual to the first page of plates and said "Now you paint the numbers you find in each of these plates one at a time all by yourself" With three- and four-year-olds who were unfamiliar with numbers, the instructions were modified as follows.

> "Follow the colored line you see inside (examiner pointing to the circle), or let's pretend that your brush is a car and the line in the circle is a road Now let me see you follow the road all the way around"

The *S* was allowed to work at his preferred speed When a discrimination error occurred, the *E* required the *S* to repeat the plate last success-

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fully completed and make a second attempt on that plate Failure of the *S* to name the number correctly or to trace it throughout its extent, constituted an error

B. Results and Discussion

As regards color naming, the data of Table 1 indicate certain trends that argue for a developmental explanation of color naming responses The successive age groups from 3 to 8 show that the percentage of boys naming the eight colors correctly ranges from 0 at the youngest age to 94 per cent at seven, although a reversion occurs at the eight-year level to 88 per cent, perhaps due to our small sample. The same data presented graphically in Figure 1 show a rather sharp separation between the groups of the pre-

TABLE 1
Color Naming Responses of 69 *S*'s between Three and Eight Years of Age

	Male			Female			
Age	No *S*'s	Number correct naming responses	Per cent correct naming responses	No. *S*'s	Number correct naming responses	Per cent correct naming responses	Per cent of total naming 8 colors correctly
3	3	0	0	2	0	0	0
4	4	1	25	4	1	25	25
5	8	1	13	8	2	25	18
6	9	8	88	9	6	66	77
7	9	8	88	9	9	100	94
8	5	5	100	4	3	75	88

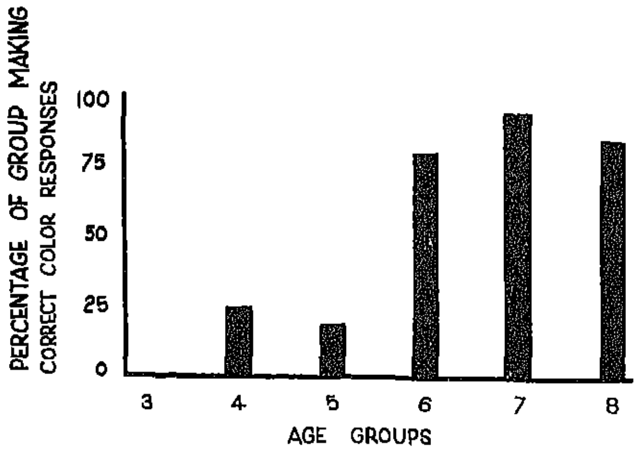

FIGURE 1
Showing Percentage of Subjects of Various Age Groups Naming Eight Colors Correctly

school ages (3, 4, 5) and the school groups (ages 6, 7, 8). These results suggest that the spurt in color naming responses is related to the child's entrance into the more formal learning situation of the first and subsequent grades. Certainly at the three-year level none of the subjects was able to label the various colors properly. Examples from our protocols show that red was called brown, blue and pink while blue was called red, purple, green, and black. Following age groups suggest a trend toward a gradual increase in effectiveness of color naming. Sex differences in color naming do not reveal themselves with any age group.

The main part of the experiment concerned the discrimination of colored figures (digits) upon backgrounds of different hues in a variety of combinations.

Results in Table 2 for subjects four years of age or older show that the particular color discriminations called for on this test are not an "either-or" affair. It should be noted that only approximately half our *S*'s trace out all the digits, and that the range extends down to 78 per cent of the total possible correct discriminations. Mention needs to be made of the conspicuous absence of three-year-olds here. It is interesting that none of the *S*'s of this age group can trace out the Dvorine digits.

TABLE 2

CORRECT DISCRIMINATIONS ON 28 COLOR PLATES BY 69 *S*'S, FOUR TO EIGHT YEARS OF AGE

Number of *S*'s	Number plates correctly discriminated	Per cent frequency of plates correctly discriminated
34	28	100
13	27	96
11	26	92
7	25	89
5	24	85
2	23	82
1	22	78

Further evidence for the specificity of color discrimination is given by the data of Table 3. While the small sampling discourages a detailed analysis, there are trends that suggest that not all hues are equally discriminable, particularly in certain combinations. Note that 100 per cent of four-year-olds discriminate a red digit on a blue background, but only 75 per cent discriminate the reverse. Of six-year-olds, 94 per cent perceive a yellow digit on a green background, but only 22 per cent trace out the green number on a yellow background. This particular combination appears to be difficult for all ages but the eight-year group.

TABLE 4

Percentage of *S*'s Correctly Discriminating 28 Dvorine Color Plates

	Total population by sex		Number discriminating 28 Dvorine color plates correctly			Percentage discriminating Dvorine plates correctly		
Age groups	No males	No females	No males	No. females	Total	% Male	% Female	% Total
3	3	2	0	0	0	0	0	0
4	4	4	2	2	4	50	50	50
5	8	8	3	3	6	38	38	38
6	9	9	2	3	5	22	33	27
7	9	9	7	6	13	77	66	72
8	5	4	4	3	7	80	75	77

Additional light is thrown on this complex problem by the results shown in Table 4 As with the color naming reactions so with the color-digit-tracing responses, there is an uneven but decided trend in the percentages *of increasing age groups that are able to trace out the* Dvorine numbers It is significant that none of the three-year-olds can perform here. For the four, five, six, seven, and eight-year groups the percentages are respectively 50, 38, 27, 72, and 77 per cent correct tracing of the numerals

As regards sex differences, Table 4 also shows that at the three-, four-, and five-year levels the percentage of both males and females discriminating

TABLE 3
DISCRIMINATION OF DVORINE PLATES OF VARIOUS COLOR COMBINATIONS BY AGE GROUPS

Plate description Figure (Digit)		Background	Age groups 4-yr	5-yr	6-yr	7-yr	8-yr
Red	—	Blue	100	100	100	100	100
Blue	—	Red	75	87	100	100	88
Green	—	Red	100	87	94	100	100
Red	—	Green	100	100	100	100	100
Red	—	Brown	100	100	100	100	100
Brown	—	Red	75	87	61	100	100
Yellow	—	Green	100	93	94	94	100
Green	—	Yellow	63	75	22	83	100
Yellow	—	Brown	100	93	100	100	100
Brown	—	Yellow	75	81	51	83	83
Blue	—	Orange	100	93	100	100	100
Orange	—	Blue	100	100	100	100	100
Blue	—	Violet	100	75	94	100	100
Violet	—	Blue	100	93	77	100	100
Green	—	Brown	100	93	100	100	100
Brown	—	Green	100	93	94	100	88

the 28 plates is the same (0, 50, and 38 per cent respectively) At the higher levels, males are generally superior with the exception of the six-year group, where the figures are 33 per cent for females and 22 per cent for males. At age seven, males lead with a figure of 77 per cent as compared with 66 per cent for females, and at the eight-year level the males stand at 80 per cent vs 75 per cent for females Differences between the sexes are less than those within the sexes, again disagreeing with traditional theory However, these results are more suggestive than conclusive and only further investigation with larger samples can yield any sort of definite answer to the questions raised here

C SUMMARY AND CONCLUSIONS

The present study utilized the rotating color disks and 28 color plates of the Dvorine Color Perception Testing Charts in an effort to explore color naming and color discrimination among 74 children, ages 3-8 and including 38 males and 36 females It was found that

1 Correct color naming was non-existent among our three-year-olds and that generally pre-school and school groups were sharply separated in the direction of superior performance of the latter. There was no suggestion of sex differences here

2 When *S*'s were asked to trace the digits on the color plates, the percentage of correct responses ranged from 78 per cent to 100 per cent of the total series of 28 plates

a Apparently not all color-combinations were equally discriminable

b The percentage of subjects making correct responses ranges from 0 at the three-year-level to 77 per cent at the eight-year-level.

c Sex differences within each sex group varied much more than between sex groups

3 Larger samples are needed to settle conclusively the several problems raised

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A STUDY OF THE LINGUISTIC FUNCTIONING OF CHILDREN WITH ARTICULATION AND READING DISABILITIES*

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Human relationships are largely dependent upon two basic forms of communication, viz , the spoken and the written word. Normal development of speaking and reading ability is therefore essential to every person in our present-day culture And yet, there are children, and even adults, whose ability to speak and read is inadequate for social intercourse It is with the children whose speech and/or reading abilities do not develop satisfactorily that this study is concerned Because of inadequate means of communication and of receiving knowledge through the printed page, these children are often handicapped in the development of satisfactory educational, personal, and social adjustment

It is the purpose of this study to investigate differences in the development *and patterning of intelligence, articulation, oral and silent reading,* vocabulary, and oral language development in four groups of second-grade children, (*a*) one consisting of children seriously defective in articulation, (*b*) another of children seriously retarded in reading, (*c*) another of children retarded in both articulation and reading, and (*d*) a control group of children who are normal in both articulation and reading.

A PREVIOUS INVESTIGATIONS RELATED TO THE PROBLEM

The literature related to the various aspects of this study is too voluminous for review within this paper. Therefore, brief reference will be made to

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[1] This monograph is based on a dissertation done in the Department of Psychology at Fordham University in partial fulfillment of the requirements for the degree of Doctor of Philosophy *This research was conducted under the supervision of* Doctor Dorothea McCarthy, whose guidance is deeply appreciated Gratitude is also expressed to Doctor Joseph F Kubis for his valuable aid in the statistical analyses of these data Special acknowledgment is made to Doctor Saul Rosenzweig for his permission to use the Picture-Association Study for Assessing Reactions to Frustration in the preliminary form designed for children The writer is also indebted to the administrators and second-grade teachers of the public schools of Belleville, Bloomfield, Caldwell, Glen Ridge, Irvington, Montclair, Nutley, Summit, Verona, and West Orange, New Jersey, whose cooperation facilitated the selection and examination of the subjects of this study

general reviews in the areas of language development, speech, and reading, and more detailed consideration will be reserved for those studies most pertinent to the present study

The most comprehensive reviews of the literature relating to language development are those prepared by McCarthy (26, 28), which appear in *A Handbook of Child Psychology,* edited by Murchison (1931 and 1933) and in *A Manual of Child Psychology,* edited by Carmichael and published in 1946 The 28th and 38th yearbooks of the National Society for the Study of Education contain abstracts of language studies, and Allen (1) and Goodenough (17) have compiled bibliographies in this field

A most complete bibliography relating to speech is that prepared by Thonssen and Fatherson (37) Since 1935, Knower has made annual reports on graduate research in the speech field which appear in *Speech Monographs,* and recent reviews of the literature have been written by Sanford (34) and by Johnson and Gardner (21)

Extensive bibliographies on reading by Betts (5, 8) were published in 1934 and 1945 Gray has presented committee reports on reading in the 16th, 20th, 24th, 37th, and 38th yearbooks of the National Society for the Study of Education Subsequent to his publication in 1925 of a summary of research related to reading, Gray has prepared annual supplements which appeared in the *Elementary School Journal* from 1926 to 1932 and in the *Journal of Educational Research* since 1933

1 *Studies of Children With Speech Defects*

Several investigations have been concerned with the development of reading ability in children having speech defects. Gibbons (16) matched 20 unselected speech cases in *CA, MA,* and *IQ* with a control group On Gray's Standardized Oral Reading Paragraphs Test (18) the mean reading grade was 1.8 for the speech defective group and 2 8 for the control group, and this difference in reading achievement was statistically significant The results of the Monroe Diagnostic Reading Examination, which was also given to the subjects, showed that the reading of the speech defectives averaged 8 grade below their arithmetic achievement Gibbons pointed out that this reading retardation of .8 school year was relatively great because the possible degree of retardation was limited by the fact that most of the children were first- or second-graders Describing the reading ability of the speech defectives in greater detail, Gibbons said · "The Reading Indices for this speech group show that only one case out of 20 rated as a superior reader, four cases were low average or borderline readers, while the rest of the group presented reading problems sufficiently severe to require remedial work" (p. 7).

Moss (30) reported an investigation of the oral reading ability of unselected speech cases from 19 schools. Thirty-six subjects, or 3.6 per cent of the senior second-grade population of 983 children, with a variety of speech defects such as foreign accent, lisping, stuttering, sound substitution, nasality, hoarseness, high pitch, rapid speech, and indistinct speech, were ranked by a speech correctionist according to their scores on an unspecified speech test. The present writer finds it difficult to understand how such qualitatively different types of defects as stuttering, hoarseness, and sound substitution, could be ranked in order of seriousness or degree of defectiveness. The speech defectives were matched in intelligence and chronological age with a group of 36 normal speakers. Comparisons of the groups were made with respect to errors and rate of reading on Gray's Standardized Oral Reading Check Test. Although differences in reading achievement favored the control group, no statistical analyses were made of the significance of the differences between the groups in reading performance. Rank-order correlations computed for the experimental group were .36 between speech ability and rate of reading, and .20 between speech ability and reading errors. Moss concluded from inspection of the median rate and error scores of the experimental and control groups that "speech defects are a definite handicap in oral reading in the second grade, both in reading and in the number of errors made" (p. 654).

Wisely confining his study to one type of speech defect, Kelly (23) investigated stuttering in college students and found that:

> The connection of reading disability to defective speech rhythm and of defective speech rhythm to reading disability independent of general intelligence indicates a common element of an essentially transient nature in speech and reading defects.
>
> Individuals who were diagnosed as speech defectives, as a group, did not show any significant silent reading disability.
>
> None of the following aspects of speech were significantly correlated with silent reading ability: articulation, voice, organization of materials in a speech, symbolic formulation and expression (pp. 198-199).

Murray (31) also limited his 18 speech defective cases to stutterers paired in age, mental ability, and grade with normal speakers. With regard to their reading ability, he stated that "The study of disintegration as measured by silent reading tests brought out the fact that stutterers appeared to be approximately one grade below normal in comprehension and two grades below normal in rate of reading When their true intelligence was considered the disparity was further increased about one-half grade" (p 273)

Confining their investigation to another type of speech defective, Johnson and House (22) studied 41 children with functional articulation defects They were compared with 33 normal speakers with respect to reading and spelling achievement. Both groups ranged in age from seven to 13 years and no subjects had *IQ*'s below 82 on the *Stanford-Binet Scale* The investigators found that 12 per cent of the articulation cases had not only been *late in beginning to talk*, but *also were reported by their teachers* as having reading or spelling disabilities Since these reports were not confirmed objectively by means of standardized test scores in reading and spelling, the evidence of educational disabilities is inconclusive

Monroe (29) also reported the incidence of reading retardation found in 65 articulation disability cases Twenty-four or 37 per cent were retarded a year or more in reading with respect to their mental age level.

2 *Studies of Children With Reading Disabilities*

Arthur (3) compared the records of 14 non-readers ranging in age from eight to 14 years with those of normal readers aged six to 10 All of the non-readers had had a minimum of two years of reading instruction after having attained a mental age of six, and none had a Binet *IQ* below 70 Although the group of non-readers had the advantage in chronological and mental age and in amount of reading instruction, the normal reading group was superior in IQ. With respect to their speech development, Arthur found that "For eight of the non-readers infantile speech, oral inactivity, or poor enunciation are recorded, as compared with two of the readers, although the readers are the younger group" (p. 263).

In an investigation of the physical and social traits associated with reading disability, Anderson and Kelley (2) analyzed the data secured from case histories of the Institute for Juvenile Research. One hundred reading-defect cases were paired with 100 normal readers of the same sex, chronological age, and *IQ* Ninety-five of the reading-disability cases had Stanford-Binet *IQ*'s below 90 and 16 were below 70 Speech defectiveness, as recorded in the case histories by many different social workers, was based on the reports of parents, teachers, or other referring agencies, rather than upon diagnosis by speech correctionists Reporting their findings, Anderson and Kelley said·

> Speech defects were found to be more frequent among the reading-disability group, one-fourth of them as compared with one-seventh of

> the control group showing such difficulties of one type or another (p 62)
>
> Speech defects occurred most frequently in the reading-disability group of low *IQ*, a third of that group having some type of difficulty Only a fifth of the reading-disability group of higher *IQ* showed speech defects, while the proportion in its control group was but one-seventeenth
>
> In total frequency of occurrence, the difference between the reading-disability and the control group was but 13 cases, a difference that is barely statistically significant (p 56)

Another study in which the data were based on clinical cases was reported by Monroe (29), who compared a reading-defect group consisting of 415 children ranging in age from six to 17 years with a control group of 101 cases of six to 11 years Although the control subjects were younger and less mature mentally than the reading-defect cases, they were superior in IQ since one control and 91 reading-defect cases were below 80 *IQ*. Monroe found that articulatory defects were observed in 18 per cent of the reading-defect group as compared with seven per cent in the control group She concluded that "Defective speech may be considered a factor in reading disability, either as one cause of the reading defect or as a result of a common cause" (p 92).

In an investigation of the causes of poor reading, Bennett (4) compared 50 poor readers in the second through the fourth grades with a control group of normal readers matched in age, *IQ*, sex, school, grade and class grouping Although the sources of the information were admittedly of questionable reliability, Bennett concluded that:

> The one factor which stood out in the physical area as most clearly associated with reading retardation was a history of speech defect Nine parents of poor readers reported some history of speech defect while of the children themselves, 13 reported such difficulties Among the controls, no parents reported this problem although six children believed they had stuttered or stammered at some time The total group difference, expressed in per cents, is 3 0 times its standard error This suggests the conclusion that a history of speech defect is apt to be coincident with poor reading It should be pointed out, however, that no child in either group appeared to be an obvious and chronic stutterer at the time of the investigation (p 78)

Bond (9) also made a study of 64 poor readers matched with 64 good readers in age, sex, school experience, and intelligence The subjects were second- and third-grade pupils in four New York City public schools in which different methods of reading instruction were employed. Bond reported that:

> The relative proportion of stutterers found in the phonetic school was higher than in the look-and-say schools, although the presence of five stutterers out of 48 cases (as contrasted with only one stutterer out of 80 cases in the look-and-say schools) is only suggestive There is, therefore, an implication that the phonetic type of reading training may elicit or possibly accentuate a tendency to stutter
>
> A more detailed analysis of these data was made because the findings did not agree with Monroe's results
>
> Speech defects were found to be prevalent in 21 per cent of those cases that were retarded in both oral and silent reading, and in 24 per cent of those cases that were not retarded in both oral and silent reading The slight difference between these two classifications is not statistically significant and probably is due to chance It seems, therefore, that wherever a consistent performance was found in silent and oral reading children who were not retarded in oral reading but were poor silent readers showed no speech defects On the contrary, 35 per cent of those children who were retarded in oral reading but were good silent readers had speech defects It is recognized in this comparison that the number of cases is not sufficient to assure reliable significance The difference, however, is so marked that it is questionable whether it can be ascribed to chance At any rate, a definite need exists to examine further the extent to which speech difficulties are operating to produce this anomalous condition (pp 37-39)

A comparison was made by Jackson (20) of 244 advanced and 234 retarded readers. On the basis of the Metropolitan Reading tests in grades four through six, children above the third quartile of reading achievement in each grade were classified as advanced readers, and those below the first quartile in each grade were designated as retarded readers Jackson found that 25 or 10 2 per cent of 244 advanced readers had speech defects as compared with 53 or 22 7 per cent of 234 retarded readers who had defective speech. He concluded that "Since the tests administered measured the rate and comprehension of silent reading and not oral ability, it is distinctly noteworthy that reading retardation may occur on the basis of speech defect" (p 127)

Shire (35) compared the language development of the most advanced and retarded readers among 300 first-grade subjects Thirty children who scored the highest in the Metropolitan Reading Test during the first term were contrasted with the 30 in the lowest decile of reading achievement Statistically significant differences were obtained between these advanced and retarded readers in average length of response, in the number of complete grammatical sentences, and in the number of elaborated sentences However, these groups also differed greatly in intelligence, the mean *IQ* for the advanced readers was *118 while that for the retarded readers was only* 99 Therefore, it is quite possible that the differences in language ability favoring the advanced readers may have been due to their greater mental maturity.

3. *Studies of the Inter-Relationships of Speech, Reading, Vocabulary, and Oral Language Development*

A few studies have attempted to measure the relationships among various aspects of language development Williams and McFarland (39) measured 70 preschool children with respect to *CA, MA,* speech sounds, word usage, vocabulary, and length, completeness, and complexity of oral language Inter-correlations among these language variables were reported for 38 three- and four-year-old subjects who completed all the tests The investigators stated that "It was found that there was a moderate correlation between all these abilities, except vocabulary, which showed a rather high degree of independence" (p. *18*). Shire (*35*) determined the inter-correlations among measures of mental ability, oral language development, and reading for 300 first-grade children

From a study of the reading progress of children in kindergarten through the third grade in Horace Mann School, Wilson, Flemming, Burke, and Garrison (40) concluded that· "Varying abilities to see, hear, and speak and varying ability or personality traits do not seem to be closely or critically related to progress in reading, as revealed by either the statistical analyses or the case studies" (p 443)

In a study of 97 first-grade subjects from four classes in a New York City public school, Gates, Bond, and Russell (15) described the method used by the speech correctionist in rating the speech of the subjects Instead of using an articulation test, defects such as stuttering or lisping were rated on a scale from 10 for perfect speech, through 7 or 6 for moderate defects, down to 0 for very serious defects Rating for foreign accent varied from *10* or *9* for no trace of foreign accent, *8* or *7* for slight accent, 3 or 2 for decided accent, and 0 for lack of any ability to speak English Therefore, low speech ratings may have been given to one child because of stuttering, to another because of poor articulation, and to another because of foreign accent These speech ratings were made at the beginning of the first, second, and third terms Six coefficients of correlation were computed and the mean *r* between freedom from speech defects and reading was .10 The investigators, noting that the correlation between reading and freedom from foreign accent was .20, acknowledged that· "In the population studied were children of many nationalities, and the influence of foreign tongues was probably greater than in a typical American school" (p. 21) The conclusion was that. "Speech defects, as found in these classes by careful examination have very little effect on reading in the mass results This does not eliminate the possibility that a serious speech defect in occasional cases may be a handicap, if not handled with skill" (p 21)

Interpreting the results of the Horace Mann study by Wilson *et al* (40) as well as their own study, Gates, Bond, and Russell (15) stated that. "Both studies agreed also in showing 'little significant relationship of vocabulary and reading progress'" (p. 31)

The most thorough and critical survey of the literature regarding the relationship between speech and reading disabilities is contained in an article by Gaines (14) The summary of this article is quoted here at length because it clarifies so well the inadequacies of previous research

> The amount of research done has been too small either to substantiate or to disprove any assumption one may wish to draw
>
> The diagnosticians of speech defects vary in these studies from the inaccurate rating of mothers to the accurate rating of speech specialists The unstandardized use of terminology in various investigations precluded the possibility of comparing results The absence of any reliable norms for speech adjustment in the general population further prevents comparisons
>
> On the other hand, reading investigators fail to specify exact types of reading used as a means of comparison, comments are lacking as to what type of reading instruction was given to the cases
>
> Until terms are defined and standardized, studies can be of value for only specific aspects of both reading and speech and any deductions we may wish to make at present must be necessarily so qualified as to be of little value (p 109)

In addition to these criticisms of previous research, others might be noted The subjects of several studies have not been representative of children in the average American school Either they were private-school children who were superior in mental ability or they were children from the New York City public schools where the incidence of foreign accent is greater than that found in the typical school

In some studies the population sampled was not suitable for a crucial investigation of the relationship between speech and reading disabilities In any one grade in just a few schools there are only a few children who are seriously retarded in speech and/or reading Therefore, studies dealing with only a few schools have not obtained a sufficient number of cases having serious deficiencies to warrant conclusions as to the relationship between speech and reading disabilities

Other investigators have failed to equate the experimental and control groups satisfactorily with the result that retarded readers and speakers were contrasted with children of greater mental ability Finally, criticism may be made of the lack of, or inadequacy of statistical treatment of the results of some of the studies. Therefore, this investigation was undertaken in an effort to study the linguistic functioning of children with articulation and reading disabilities by more controlled methods than have hitherto been employed.

B SUBJECTS

1. *Preliminary Selection of Subjects*

Children in the latter half of the second year of school were chosen for this study because at this level they have had sufficient instruction in reading so that those who are seriously retarded in reading can be selected satisfactorily Furthermore, any speech difficulties which persist after the seventh birthday may be considered unusual enough to be classified as articulation defects

In order to find enough children with articulation and reading difficulties of such seriousness that they would be representative of clinically severe and specific speech and reading disabilities, it was necessary to select them from a large number of schools Ten public school systems in Essex and Morris counties of New Jersey authorized the undertaking of this research. Because a few of the schools in some of the towns had large foreign populations, they were omitted from this study as it was desirable to obtain subjects not influenced by foreign language The second-grade teachers in the schools chosen for the study were asked to list the names of the children in their classes who were considered speech detectives or serious reading problems As a result of totaling the data from all questionnaires, 175 children from 54 schools were judged by 89 teachers to be defective in speech and 163 were judged poor readers Of the total population of 2,147 second-grade children, 8 15 per cent were reported by the classroom teachers to be defective in speech and 7.59 per cent were reported to be poor readers

2 *Testing of Subjects*

Inasmuch as it has been shown in previous investigations that linguistic functions bear some relation to general mental ability, it was considered advisable to obtain a measure of the intelligence of the subjects Therefore, the Pintner-Durost Elementary Test, Scale I, Form *B* (32), which does not require reading ability, was given to all of the poor readers, to the speech defectives, and also to 25 entire second-grade classes From these classes the control group of subjects was selected To obtain more objective and reliable measures of the articulation and reading retardation of the children than can be obtained by teachers' estimates, standardized tests were employed. The children who were listed by their teachers as poor readers were given Gray's Standardized Oral Reading Paragraphs Test (18), and those listed as speech defectives were tested with Stinchfield's Handy-Pack Speech Test (36) The administration of the intelligence, reading, and articulation tests was completed within a period of 44 days (February 5th to March 20th, 1945) All tests were given by the investigator, who had had graduate training and experience, not only in psychological testing, but also in diagnosing speech defects

After this preliminary testing, 211 children were selected for further examination which occurred between April 9th and May 28th, 1945, a period of 50 days The tests were administered in the following order (*a*) the Durrell-Sullivan Reading Capacity Test, Primary, Form *A*, Test 1, Word Meaning (13), which requires no reading, was used to measure understood vocabulary, (*b*) the Durrell-Sullivan Reading Achievement Test, Primary, Form *A*, Test 1, Word Meaning (13), was used to measure silent reading ability, (*c*) a modification of an articulation test designed by McCarthy (27) to elicit responses containing the phonemes of most frequent occurrence in the sounds of spoken language was the measure of articulation defectiveness; (*d*) Gray's Standardized Oral Reading Paragraphs Test (18) was used to measure oral reading achievement, and (*e*) Rosensweig's Picture-Association Study for Assessing Reactions to Frustration (33), in a preliminary form designed for children, was used to obtain oral language samples to be analyzed for length, complexity, and completeness of response.

All of these tests were administered individually with the exception of the Durrell-Sullivan Reading Capacity and Achievement tests, which were occasionally given to small groups never exceeding five in number. A room for these special examinations was provided in each school and every precaution was taken to secure favorable testing conditions

3. *Final Criteria for Selection of Subjects*

After these examinations were completed, the children were classified with respect to their reading and speech defectiveness. The selection of subjects was made according to the following criteria· (*a*) Children who were defective in the articulation of at least one phoneme of frequent occurrence in the sounds of spoken language were designated as *Articulation-Disability Cases.* (*b*) Children who scored from zero to four on Gray's Standardized Oral Reading Paragraphs Test were designated as *Reading-Disability Cases* Inasmuch as such scores are equivalent to a reading grade of 1 9 or less, these cases showed a minimum retardation of 1 0 school year since the average grade placement of the subjects was 2 9 at the time of final testing. (*c*) Children designated as *Reading-Articulation-Disability Cases* were those who met the criteria for both the *Reading-* and *Articulation-Disability Cases* (*d*) The children designated as *Control Cases* were selected from those in the 25 entire classes examined who had not been classified by their teachers as defective in speech or in reading. In addition, they made no errors on the articulation test and their grade equivalent scores were 2 1 or more on Gray's Standardized Oral Reading Paragraphs Test (*e*) Because mental retardation may be a cause of lack of normal development in speech, reading, vocabulary, and language, no subjects with *IQ*'s below 76 were used in any of the groups

4 *Incidence of Children With Articulation and/or Reading Disabilities*

The number of children diagnosed as functional articulation-disability cases was 71 of 2,147 second-graders, or 3 31 per cent Louttit and Halls (24) reported that 5 76 per cent of the second-graders in their extensive survey were reported to be defective in articulation The smaller percentage obtained in the present study is probably the result of the diagnostic procedure which excluded children whose articulation defects may have been due to organic causes or to bilingual background

According to the criterion employed in this study, 67 of 2,147 second-graders or 3 12 per cent, were classified as reading-disability cases Since other investigators, as reported by Betts (6), have estimated the incidence of reading disabilities from two to 15 per cent, the present estimate of 3 12 per cent is most conservative, including only those children whose reading is extremely poor

Twenty-seven of 2,147 second-graders, or 1 26 per cent, were seriously deficient in both articulation and reading Forty per cent of 67 poor readers had an articulation defect, and 38 per cent of 71 cases identified as articulation cases were also reading-disability cases Since many other investigators have also noted the frequency of occurrence of the double handicap, the existence of a significant relationship between reading and speech defectiveness is confirmed.

5. *Incidence of Boys and Girls With Articulation and/or Reading Disabilities*

Many observers have noted that reading and speech disabilities are more commonly found in boys than in girls. In the present investigation the usual preponderance of boys with these handicaps was found. Table 1 shows the numbers and percentages of each sex who had articulatory and/or reading disabilities.

TABLE 1
NUMBER AND PERCENTAGE OF EACH SEX WITH ARTICULATION AND/OR READING DISABILITIES

	Boys		Girls		All
	N	%	*N*	%	*N*
Articulation-disability cases	33	75.0	11	25.0	44
Reading-disability cases	27	67.5	13	32.5	40
Reading-articulation-disability cases	21	77.8	6	22.2	27

Testing the significance of the difference between the observed and expected frequency of boys and girls with articulation disabilities, the obtained chi-square was 11.00, equivalent to a *t*-value of 3.32, which is significant at the one per cent level of confidence. Therefore, it may be concluded that the preponderance of boys in the articulation-disability category was greater than can be reasonably attributed to random variation.

The chi-square obtained in testing the difference between the observed and expected frequency of boys and girls with reading disabilities was 4.90, equivalent to a *t*-value of 2.21, which is significant at the five per cent level of confidence. The probability of obtaining a *t*-value as large or larger than 2.21 is less than .05, approaching the value .02.

Testing the significance of the difference between the observed and expected frequency of boys and girls with reading and articulation defects, the obtained chi-square value was 8.33, equivalent to a *t*-value of 2.89, which is significant at the one per cent level, showing that the greater incidence of boys than of girls who have both articulation and reading disabilities is probably not due to random variation. Apparently, therefore, these are functions in which a real sex difference exists.

In order to avoid biasing the results by differing representation of the two sexes in the various groups, the proportion of male to female subjects was made approximately constant from group to group. All of the reading-articulation-disability cases were used as one experimental group, and the numbers of boys and girls in the other groups were adjusted to maintain the same relative proportion of the two sexes. There are approximately three and one-half times as many boys as girls in each group.

TABLE 2

DISTRIBUTION OF EXPERIMENTAL SUBJECTS ACCORDING TO TOWNS, SCHOOLS, AND CLASSES

Town	Schools	Classes	Control group	Articulation-Disability group	Reading-Disability group	Reading-Articulation-Disability group	All groups
Belleville	8	9	11	7	3	7	28
Bloomfield	8	10	11	6	9	6	32
Caldwell	3	4	4	1	3	1	9
Glen Ridge	3	3	5	2	0	2	9
Irvington	4	5	11	7	5	2	25
Montclair	2	2	10	1	1	2	14
Nutley	4	7	11	5	1	3	20
Summit	5	6	3	9	6	1	19
Verona	2	2	0	1	1	1	3
West Orange	4	5	8	3	6	2	19
Totals	43	53	74	42	35	27	178

6 *Language Background of Subjects*

Every effort was made to avoid using children whose linguistic development was complicated by bilingualism. In most of the school systems the personal data records of the children, which gave the birthplace of the parents, were inspected In the schools which did not record this information, the teachers or principals reported whether or not the parents had a foreign accent Therefore, it was possible to determine that the parents of most of the subjects were either born in the United States or did not have a foreign accent This information was available with regard to at least 89 per cent of the subjects in each group and, furthermore, in the speech examination, the investigator had ruled out children who showed any trace of foreign accent Therefore, it is fairly certain that none of the subjects was influenced by foreign language background in the home

7. *School Training of Subjects*

Table 2 gives the distribution of the final experimental subjects according to towns, schools, and classes Inasmuch as the 178 experimental subjects were chosen from 53 different classes from 43 schools in 10 different towns, differences in their articulation and reading ability cannot be dependent upon differences in school instruction Furthermore, the subjects who comprise the Control Group are members of many of the same classes as the children with articulation and reading disabilities. Hence, the groups to be compared, had, presumably, the same instruction. Such differences as may exist between the groups in linguistic functioning are probably not attributable to differences in school training

8 *Age of Subjects*

Table 3 offers a comparison of the means and variability of the groups with respect to chronological age. The average age of the subjects was 92 69 months, which is approximately equivalent to seven years nine months. It should be borne in mind that these ages were computed in the preliminary testing period between February 5th and March 20th By the time of the final testing of the various linguistic functions (April 9th to May 28th), three months had elapsed so that the mean age of the subjects then was approximately eight years.

The analysis of variance method was used to test the significance of the group and sex differences in age. Since the F-ratio between groups was 0 93, an obviously insignificant value, it is evident that the age differences among the various groups are negligible However, the *F*-ratio between sexes was 4.71, a significant value at the five per cent level of confidence. Separate analyses of the differences in age of the boys and girls showed that the only *t*-value of significance was obtained in the Reading-Disability Group where the difference between the boys and girls with respect to age was significant at the five per cent level of confidence The fact that the boys had an advantage of approximately four months of age over the girls in the Reading-Disability Group should be borne in mind in subsequent comparisons of the sexes in linguistic functioning However, the very slight age differences between the boys and the girls of the other groups were not significant.

TABLE 3
MEANS AND VARIABILITY OF THE GROUPS IN CHRONOLOGICAL AGE (IN MONTHS)

	Control group	Articulation-Disability group	Reading-Disability group	Reading-Articulation-Disability group	All groups
Number					
Boys	58	33	27	21	139
Girls	16	9	8	6	39
All	74	42	35	27	178
Mean					
Boys	92.93	93.24	94.41	91.67	93.10
Girls	90.88	92.89	90.00	91.33	91.23
All	92.49	93.17	93.40	91.60	92.69
SD					
Boys	4.24	4.99	5.19	3.79	4.63
Girls	2.67	4.43	4.06	6.90	4.38
All	4.05	4.87	5.28	5.66	4.64

C INTELLIGENCE

In any study of linguistic functions the measurement of the intelligence of the subjects is of vital importance because it is generally recognized that verbal abilities are significant constituents of general mental ability For this reason measures of vocabulary, reading, and sentence development are often included in tests of intelligence and it is, therefore, difficult to differentiate clearly between intelligence so measured and linguistic ability

1. *Examination of Intelligence*

The Pintner-Durost Elementary Test, Scale I, Form *B* (32), was selected for the measurement of the intelligence of the subjects The reliability of this scale, as described in the manual, is 92, and its validity, as determined by correlating the *Picture Content and Reading Content scales*, is 78. Because it is composed entirely of pictures and requires no reading ability, this test is especially suitable for use with children who are retarded in reading. At the second-grade level, information acquired through experience in reading would probably be insufficient to affect performance on a non-reading intelligence test. Therefore, it is unlikely that lack of reading achievement adversely affected the scores of the groups composed of reading-disability cases. However, since ability to comprehend oral language is required by this mental test, it is possible that the performance of the handicapped subjects was somewhat affected by difficulty in oral language comprehension.

2. *Group and Sex Differences in Mental Age and IQ*

Table 4 shows the means and variability of the groups with respect to mental age and IQ. The mean mental age for all subjects was 91.01

TABLE 4
MEANS AND VARIABILITY OF THE GROUPS IN *MA* AND *IQ*

	Control group	Articulation-*Disability* group	Reading-*Disability* group	Reading-Articulation-*Disability* group	*All* groups
Number					
Boys	58	33	27	21	139
Girls	16	9	8	6	39
All	74	42	35	27	178
Mean MA					
Boys	92.91	93.24	91.82	87.52	92.80
Girls	84.25	89.56	82.13	81.67	84.64
All	92.61	92.45	89.60	86.22	91.01
SD MA					
Boys	10.95	9.60	11.78	9.87	10.95
Girls	7.47	5.90	8.40	7.47	7.90
All	11.20	9.07	11.32	9.70	10.89
Mean IQ					
Boys	101.53	99.61	96.74	95.43	99.22
Girls	92.56	96.56	90.88	89.33	92.64
All	99.60	98.95	95.40	94.07	97.78
SD IQ					
Boys	11.04	10.86	9.94	10.57	10.98
Girls	8.39	5.94	8.94	8.02	8.32
All	11.15	10.08	10.03	10.38	10.80

months or seven years seven months It should be remembered that, since the measures of linguistic functioning were obtained three months after the date for which the mental ages were computed, the average mental age of all the subjects was approximately seven years ten months when the linguistic variables were measured Although the total groups are fairly comparable with respect to mental age, the boys are consistently superior in mental age to the girls in all the groups

The mean *IQ* of 97 78 for all subjects indicates that the experimental population is composed of children of average mental ability Because of the existence of group and sex differences in *IQ*, the analysis of variance method was used to test their significance The *F*-value between groups was 2.67, which is statistically significant at the five per cent level of confidence and probably cannot be attributed to random variation Hence it is evident that at least a significant difference in intelligence exists between some of the groups Similarly, the *F*-value of 12.16 between sexes was significant at the one per cent level of confidence which precludes the possibility of random variation Therefore, some significant difference in intelligence exists between some of the groups of boys and girls

Separate analyses were made of the group and sex differences in *IQ* Inasmuch as the *t*-value (0 31) obtained between the Control and Articulation-Disability groups is insignificant, it is clear that the Articulation-Disability Group is not significantly different in *IQ* from the average sample of control subjects This testifies to the hypothesis that the articulation disabilities are specific and not due to general mental inability The Reading- and Reading-Articulation-Disability groups, however, are significantly different in *IQ* from the Control Group at the 10 and 5 per cent levels respectively, with *t*-values of 1 88 and 2 22 These findings are in accord with the general tendency for children with reading difficulties to be of lower mental ability than good readers And it is not surprising that the children with the double handicap show still greater inferiority in *IQ* to the Control Group, the difference being significant at the 5 per cent level of confidence

The obtained *t*-value of 1 51 shows that the difference in *IQ* between the Articulation-Disability Group and the Reading-Disability Group is significant only at the 20 per cent level, but the degree of significance changes to the 5 per cent level when the Articulation-Disability Group is compared with the Reading-Articulation-Disability Group, the *t*-value being 1.97 Again it is not surprising that children with the single handicap of articulatory difficulty are mentally superior to the subjects with the double handicap

No significant difference in mental ability exists between the *IQ*'s of the Reading- and the Reading-Articulation-Disability groups

The difference in *IQ* between the boys and the girls of the Control Group is explicable in terms of the selection of these subjects because a deliberate effort had been made originally to match the mental ability of the girls of the Control Group with that of the girls in the other groups Therefore, the obtained sex difference favoring the boys in *IQ* in the Control Group is of no importance to this study

However, the sex differences favoring the boys in *IQ* in the other groups present interesting theoretical implications The only *t*-value of statistical significance was obtained in the Reading-Disability Group where the difference between the sexes in *IQ* is significant at the 5 per cent level of confidence, the *t*-value being 2 41 The presence of this significant difference shows that the superiority of the boys in mental ability is probably not due to random variation and suggests two hypotheses: (*a*) The boys in the Reading-Disability Group may present a more specific type of reading disability than the girls whose disabilities may be due more to general mental disfunction. (*b*) Girls normally earn a higher proportion of their *IQ* scores on verbal items and boys usually earn proportionately more on non-verbal items Therefore, it is possible that girls, who are handicapped linguistically, are penalized more severely on mental tests than boys Although the sex differences in *IQ* in the other groups are not significant, the trend for the boys to be superior to the girls is again evidenced.

3 *Necessity for Covariance Analysis*

Because the tests have demonstrated the existence of some significant differences in mental ability between groups and between sexes, it is necessary to use the covariance method which statistically equates the groups and sexes in *IQ* before testing the significance of the differences found between the groups or sexes in the linguistic functions An estimate of the true regression of each of the experimental variables on *IQ* is to be used to adjust the means of the linguistic measures for each group and sex in order to compensate for differences in intelligence This adjustment of group and sex means having been accomplished, their comparability is assured and they may then be tested for significance of differences in the linguistic functions.

D ARTICULATION

One of the criteria for selection of subjects in this study was proficiency of articulation Surveys of school children have shown that defective articulation is the most common type of speech defect and that the greatest gains in the articulatory efficiency of school children are made in the first grade. According to West, Kennedy, and Carr (38), "Normally all of the sounds of speech are developed by the time the child is seven years old" (p 34) Therefore, for this study, children in the latter half of the second grade were selected on the reasonable assumption that continuance of poor articulation after seven years of age is sufficiently unusual to be diagnosed as defective speech

1 *Examination of Articulation*

As a measure of defectiveness of articulation a modification of the McCarthy Articulation Test (27) was employed This test provides for the examination of the English speech sounds which occur most frequently in the word lists of Dewey (11) and Horn (19), which are based on samples of adult and child language respectively Since all of the test words are included in the 1,000 words most frequently used by kindergarten children according to Horn, they are so commonly spoken that any mispronunciation may be attributed to articulatory defectiveness rather than to lack of familiarity with the words on the part of seven-year-olds

The testing of vowel sounds was omitted from this study because, by the time children are in second grade, gross mispronunciation of the vowels is uncommon, and the intelligibility of speech is more dependent upon the correct pronunciation of consonants than of vowels Furthermore, as West, Kennedy, and Carr (38) point out, "The vowels are so unstable as sound units that much leeway is allowed in their pronunciation" (p xxii). Therefore, only consonants and consonant blends were tested The 50 words elicited by the examiner's questions contained 20 consonant blends and 23 consonants, some of which were tested in initial, medial, and final positions, making a total of 70 sounds.

Children who were defective in the articulation of at least one of these sounds of frequent occurrence in spoken language were designated as *Articulation-Disability Cases* Children with cleft palate, spastic paralysis, voice disorders, stuttering, foreign accent, and pathological eye conditions were not included in any of the experimental groups If no organic cause was apparent to the examiner or known to the teacher, the speech defect was considered *functional.* Only children with functional articulatory defects were selected as subjects for this study. This restriction necessitated the elimination of many children who had difficulty with the sibilant sounds because of malocclusion or the loss of deciduous teeth Although it was impracticable in this study to give individual audiometer tests, the examiner watched for signs of hearing loss and excluded any children whose articulation was apparently affected by hearing difficulty.

2. *Group and Sex Differences in Articulation*

The results of the articulation test are shown in Table 5 in terms of the means and variability of articulation errors for the different groups. The subjects of the Control and Reading-Disability groups had been selected because they made no errors on the articulation test. The 69 children in the Articulation- and Reading-Articulation-Disability groups combined had a mean error score of 8.52. The number of defective sounds ranged from 1 to 36 for all children with articulatory difficulty.

TABLE 5
MEANS AND VARIABILITY OF THE GROUPS IN ARTICULATION ERRORS

	Control group	Articulation-Disability group	Reading-Disability group	Reading-Articulation-Disability group	Articulation- and Reading-Articulation-Disability groups
Number					
Boys	58	33	27	21	54
Girls	16	9	8	6	15
All	74	42	35	27	69
Mean					
Boys	0	8.70	0	6.33	7.78
Girls	0	14.11	0	6.83	11.20
All	0	9.86	0	6.44	8.52
SD					
Boys	—	6.18	—	8.16	7.11
Girls	—	7.95	—	5.87	8.03
All	—	6.96	—	7.71	7.45

A comparison of the two groups with speech disability shows that the children with the single handicap of articulation defect made more errors (mean 9.86) than those with the double handicap of articulation and reading disability (mean 6.44). This apparent superiority in speech of those with the double handicap is consistent whether the boys or the girls of the two groups are compared. An analysis of covariance of *IQ* and articulation errors was undertaken to determine whether the differences between the Articulation- and Reading-Articulation-Disability groups were significant when the possible effect of differences in intelligence were eliminated. Although the *F*-value between groups (3.40) is not statistically significant according to the criterion used in this study, it is significant at the 10 per cent level and approaches statistical significance at the 5 per cent level Therefore, it is probable that a real difference in articulation exists between the children with the double handicap and those with only articulation disability. Thirty-seven per cent of the Reading-Articulation-Disability Group made only one error on the articulation test as compared with 14 per cent of the Articulation-Disability Group Generally more articulation errors were made by those defective in articulation but not in reading A logical explanation of this trend toward superiority of those children exhibiting the double handicap of reading and articulation disabilities might be that a selective factor was operative in the promotion of children from first to second grade Perhaps the first-grade teachers retained children who were doubly handicapped in first grade unless they tended to speak with more clarity or read with greater success than those with only an articulatory difficulty, and hence the more severe cases of double handicap were not found in second grade

The *F*-value between sexes (2 47) does not attain the level of significance required even at the 10 per cent level of confidence. Therefore, it is probable that the apparent superiority of the boys over the girls in articulatory ability can be ascribed to random variation

E. READING

1 *Definition of Reading Disability*

Criteria for designating poor readers as cases of specific reading disability have usually been based on the amount of discrepancy between objective measures of reading achievement and achievement in other school subjects or between reading age and mental age Because it was impracticable in this research to measure the school achievement of the subjects except in reading, the criterion of reading disability formulated by Durrell (12) was used He states that: "Usually a child is said to have 'specific reading disability' or to be seriously retarded in reading when his reading achievement is a year or more below his mental age" (p 278). Many investigators have contrasted the best readers with the poorest readers in a grade, but the latter are not necessarily cases of specific reading disability It is probable that few children with really severe reading retardation receive regular promotions especially in the intermediate grades, and therefore most of the poor readers in any grade are not seriously enough retarded to be classified as disability cases In order to study children with severe reading retardation it is necessary either to use children referred to clinics for remedial reading or to select children from a very large school population. The latter procedure was employed in this study, which sampled a second-grade population of 2,147 children from 89 classes in 54 schools in 10 towns.

2 *Examination of Oral Reading*

In order to contrast children who are seriously retarded in reading with those of normal ability, Gray's Standardized Oral Reading Paragraphs Test (18) was used as a criterion measure in this study. This consists of short paragraphs steeply graded in difficulty so that estimates of the reading achievement of children in grades one through eight may be obtained in a short time. The first few paragraphs are so easy that an average child in grade 2.0 can read the first paragraph of 48 words with little difficulty By the time an average reader is in grade 2 9 he can read at least two paragraphs containing 97 words.

In the preliminary testing period all of the children reported by their teachers as poor readers were measured by this test. In the final testing period, not only the poor readers, but also the other subjects were thus measured in oral reading. The fact that the performance of the poor readers remained so low on repetition of this test is further evidence of the severity of their reading handicap, as there had been a three-months interval during which rapid progress in reading would have been expected of children of this age and grade placement. The test was administered individually and scored according to the directions prescribed by the author in the manual. Both accuracy and speed of oral reading are taken into consideration in calculating the raw scores.

The results of this test were used as one of the criteria for the selection of the subjects for the various groups. Children whose raw scores were five or greater (equivalent to a grade score of 2.1 or more) were considered normal readers and placed either in the Control Group or in the Articulation-Disability Group, depending upon their articulatory ability. Children who scored four or less (equivalent to a grade score of 1.9 or less) were designated as Reading-Disability Cases and placed either in the Reading-Disability Group or in the Reading-Articulation-Disability Group, depending upon their speaking ability.

3. *Group and Sex Differences in Oral Reading*

Table 6 shows the means and variabilities of the oral reading grade and raw scores of the experimental groups Inasmuch as the subjects had a grade placement of 2.9 at the time of testing, the Reading- and Reading-

TABLE 6
MEANS AND VARIABILITY OF THE GROUPS IN ORAL READING GRADE AND RAW SCORES

	Control group	Articulation-Disability group	Reading-Disability group	Reading-Articulation-Disability group	All groups
Number					
Boys	58	33	27	21	139
Girls	16	9	8	6	39
All	74	42	35	27	178
Mean grade score					
Boys	3.6	3.1	1.4	1.4	2.8
Girls	3.6	3.2	1.4	1.6	2.8
All	3.6	3.1	1.4	1.4	2.8
Mean raw score					
Boys	13.86	10.91	1.19	1.29	8.80
Girls	13.63	12.00	0.13	1.67	8.64
All	13.81	11.14	0.94	1.37	8.76
SD raw score					
Boys	5.41	5.02	1.39	1.45	7.10
Girls	5.11	2.94	0.33	1.70	6.95
All	5.35	4.67	1.31	1.52	7.07

Articulation-Disability groups with mean reading grade scores of 1.4 evidently had an average retardation of 1.5 school years. Since the highest reading grade score obtained by any of these reading-disability cases was 1.9, they were all retarded at least one full year in oral reading with respect to grade placement.

A comparison of the mean grade score of the Reading-Disability Group (1.4) with that of the Control Group (3.6) emphasizes the contrast in their achievement. The difference of 2.2 school years in oral reading ability is further evidence of the seriousness of the retardation of the reading-disability cases.

The mean mental age of the Reading- and Reading-Articulation-Disability groups was approximately 88 months at the time of the preliminary testing. Three months later, during the final testing period, the mean mental age of these retarded readers was approximately 91 months, and their mean oral readings age was 78 months. Therefore, the discrepancy of 13 months between mental and reading ages is more than sufficient to satisfy Durrell's (12) criterion for specifying retarded readers as cases of specific reading disability.

Group and sex differences in oral reading are not as well illustrated by the grade scores as by the raw scores. In many investigations the control group which is compared with the poor readers is composed of children who are excellent readers. This is not the case in this study, the Control Group consists of average readers, some of whom are actually below the norm in *oral reading for their grade placement* In spite of this fact, great contrast is shown between the mean oral reading scores of the average readers (Control and Articulation-Disability groups) and the means of the reading-disability cases (Reading- and Reading-Articulation-Disability groups)

Because the Control Group appears to be somewhat superior to the Articulation-Disability Group in oral reading, an analysis of covariance of *IQ* and oral reading achievement was made. The *F*-value between groups is 18 93, which is significant at the one per cent level of confidence Therefore, it may be concluded that, after elimination of group differences in *IQ*, there is a highly significant difference in oral reading between the control subjects and the articulation-disability cases even when the latter exclude cases of specific reading disability Inasmuch as the range in reading scores of these two groups is identical (5-24), it is all the more remarkable that they differ so greatly in oral reading ability. The logical explanation is that lack of articulatory proficiency unfavorably affects the oral reading achievement even in children who are not seriously retarded in reading, or else that the difficulty in both articulation and oral reading results from a common cause. The sex differences in oral reading between the boys and girls of these groups are not statistically significant.

In order to analyze the difference in oral reading between the Reading- and the Reading-Articulation-Disability groups, another scoring system had to be devised because of the preponderance of zero raw scores when Gray's system is followed Therefore, the total number of errors made by each child in reading the first two paragraphs was used as the basis for statistical analysis. A slight superiority in favor of the Reading-Disability Group was found since the children in that group made fewer errors than those in the Reading-Articulation-Disability Group The sex differences favor the boys as their error scores are lower than those of the girls in the Reading- and Reading-Articulation-Disability Group. An analysis of covariance of *IQ* and oral reading errors was undertaken to determine if the differences existing between the groups and between the sexes were significant After due allowance has been made for differences in *IQ*, group differences in oral reading errors are obviously insignificant as shown by the *F*-value of 0 42. However, the *F*-value between sexes, 4 83, is significant at the 5 per cent level of confidence. This shows that some significant difference in oral reading errors exists between the boys and the girls of the Reading- and/or the Reading-Articulation-Disability groups An adjustment of the means of the sexes on the basis of the regression of oral reading errors on *IQ* was made in order to eliminate the effect of sex differences in *IQ* In analyzing the difference between the adjusted oral reading error means of the boys and the girls in the Reading-Disability Group, the obtained *t* is 3.05, a significant value at the one per cent level of confidence. Therefore, it appears that a significant difference exists between the oral reading achievement of the boys and of the girls in the Reading-Disability Group which favors the boys, inasmuch as the girls made twice as many errors on the average. However, two factors should be considered in interpreting this difference The comparative inferiority in oral reading of the girls is probably due to the manner in which they were selected. As previously mentioned, in order to maintain the same proportion of male to female subjects in each group, it had been necessary to eliminate five girls from the Reading-Disability Group, and the eight girls retained in this group were the poorest readers Furthermore, the boys of this group had a significant advantage over the girls in chronological age amounting to four months. If neither of these factors had been operative, the sex difference in oral reading ability probably would not have occurred or would have been statistically insignificant Using the same test of significance for the difference between the adjusted means of the boys and of the girls in the Reading-Articulation-Disability Group, the *t*-value is 0 523, obviously a nonsignificant value. Therefore, although the boys made fewer errors, no significant difference in oral reading as measured by number of errors exists between the boys and the girls of this group.

4 *Examination of Silent Reading*

Inasmuch as differences in silent reading as well as oral reading may exist between children with and without articulatory difficulty, silent reading was also measured in the experimental groups. For this purpose the Durrell-Sullivan Reading Achievement Test (13), Test 1. Word Meaning, which requires 10 minutes and is intended for use in Grades 2 5 to 4 5, was administered to all of the subjects during the final testing period This test presents short sentences to be completed by the choice of one of five possible words It was administered individually or in groups never exceeding five in number, and scored according to the directions contained in the manual

The results are shown in Table 7 in terms of the grade and raw scores obtained by the various groups in silent reading The Control Group is

TABLE 7
MEANS AND VARIABILITY OF THE GROUPS IN SILENT READING GRADE AND RAW SCORES

	Control group	Articulation-Disability group	Reading-Disability group	Reading-Articulation-Disability group	All groups
Number					
Boys	58	33	27	21	139
Girls	16	9	8	6	39
All	74	42	35	27	178
Mean grade score					
Boys	2.9	2.8	2.2	2.2	2.6
Girls	2.9	2.8	2.1	2.2	2.6
All	2.9	2.8	2.2	2.2	2.6
Mean raw score					
Boys	14.09	11.70	4.85	4.95	10.35
Girls	14.06	11.89	3.50	5.17	10.03
All	14.08	11.74	4.54	5.00	10.28
SD raw score					
Boys	8.16	8.32	2.81	3.17	7.99
Girls	8.38	3.90	3.16	2.11	7.41
All	8.21	7.59	2.95	2.97	8.87

at the norm in reading inasmuch as its mean silent reading achievement is identical with its grade placement (2.9) at the time of testing. The Articulation-Disability Group appears only slightly inferior with a mean of 2.8. All the reading cases have an average of 2.2 in silent reading. Evidently, the subjects who were selected as reading-disability cases on the basis of achievement in oral reading also experienced considerable difficulty in silent reading. The degree of their average retardation is equivalent to 0.7 of a school year on this criterion.

Although the group differences in terms of grade equivalents seem small, the raw scores show the great contrast between the groups. An analysis of the covariance of *IQ* and silent reading between groups and between sexes was based on raw scores. After due allowance has been made for differences in *IQ*, the obtained *F*-value between groups in silent reading (18.44) is significant at the one per cent level of confidence. Therefore, some difference in silent reading existing between some of the groups cannot be attributed to random variation. However, the *F*-value obtained when the sexes are compared (0.96) is obviously insignificant and therefore the hypothesis that differences in silent reading between the sexes are due to random variation cannot be rejected.

An adjustment was made of the group means on the basis of the regression of silent reading on *IQ* and separate analyses of the significance of the differences in silent reading between the adjusted means of the various groups were undertaken The *t*-value between the Control and Articulation-Disability groups is 1 77, a value of significance at the 10 per cent level of confidence. It is possible that the difference in silent reading between the Control and the Articulation-Disability groups is due to random variation. In a logical consideration of this result, the experimental design must be reconsidered The Control and Articulation-Disability groups were both restricted to children whose oral reading was at least equivalent to Grade 2 1 If no such restriction had been placed upon the range of these groups, it is probable that the Control Group would have proved even more superior to the Articulation-Disability Group in silent reading because children with both articulation and reading disabilities could have been included in the latter group. In view of the limitation imposed on the range of reading of this group it is all the more remarkable that such a large difference in silent reading was found between the normal and handicapped speakers. It may, therefore, be concluded that there is little probability that chance factors are responsible for the superiority in silent reading of the control subjects as compared with the children with articulatory defects.

Testing the significance of the difference between the adjusted means of the Control Group versus the Reading-Disability Group and the Reading-Articulation-Disability Group, the obtained *t*-values were 6.52 and 5.41 respectively As was to be expected from the experimental design, these results are both highly significant and show beyond doubt that the control subjects were superior in silent reading as well as in oral reading to the reading-disability cases.

Statistical comparisons of the Articulation-Disability Group with the Reading-Disability Group and with the Reading-Articulation-Disability Group also revealed significant *t*-values· 4 32 and 3 56 respectively, significant at the one per cent level of confidence The superiority in silent reading of the children who are merely handicapped in articulation over the retarded readers is evident The fact that the differences between the groups in silent reading are significant demonstrates the validity of the selection of the various experimental groups on the basis of oral reading achievement.

The final analysis showed that no significant difference in silent reading exists between the Reading-Disability and the Reading-Articulation-Disability groups (*t* is 0.46) The experimental design was undoubtedly responsible, because, in the selection of subjects, these groups were identically restricted in oral reading ability.

F. VOCABULARY

1. *Examination of Vocabulary*

Because previous investigations have shown that vocabulary is a valuable measure of linguistic development, it was used as one of the measures in this study. Inasmuch as some of the experimental subjects were reading-disability cases, a non-reading test, the Word Meaning part of the Durrell-Sullivan Reading Capacity Test (13), was used which measures understood vocabulary. This requires the selection of one picture out of five possible choices to illustrate the words pronounced by the examiner. The test is intended for children in Grades 2.5 to 4.5 and is usually completed within 10 minutes. It was administered during the final testing period to all of the subjects either individually or in small groups never exceeding five in number and was scored according to the directions contained in the manual.

2. *Group and Sex Differences in Vocabulary*

Table 8 presents the results of the vocabulary test for the various experimental groups in terms of grade and raw scores. The mean grade score for all subjects was 2.8, which shows a slight, though probably insignificant, retardation in understood vocabulary with respect to the grade placement of

TABLE 8
MEANS AND VARIABILITY OF THE GROUPS IN VOCABULARY GRADE AND RAW SCORES

	Control group	Articulation-Disability group	Reading-Disability group	Reading-Articulation-Disability group	All groups
Number					
Boys	58	33	27	21	139
Girls	16	9	8	6	39
All	74	42	35	27	178
Mean grade score					
Boys	3.1	3.0	2.9	2.6	2.9
Girls	2.6	2.4	2.4	2.1	2.4
All	3.0	2.8	2.8	2.5	2.8
Mean raw score					
Boys	26.71	25.61	24.93	22.29	25.43
Girls	21.81	19.56	19.63	16.83	20.08
All	25.65	24.31	23.71	21.07	24.26
SD raw score					
Boys	7.69	7.17	7.66	5.64	7.44
Girls	5.79	5.19	6.42	4.37	5.86
All	7.59	7.23	7.73	5.84	7.46

the subjects, 2 9 The relative standing of the groups is better illustrated by the raw scores. In order to make due allowance for group and sex differences in intelligence in analyzing these data, an analysis of covariance of *IQ* and vocabulary was made The resulting *F*-value between groups (1 40) is not significant Although the differences between the groups in vocabulary are probably due to random variation, a trend is shown for the children who are retarded in articulation or reading to be inferior in vocabulary to the normal readers and speakers, and the children with the double handicap tend to be inferior in vocabulary to those with the single defect

Between sexes the *F*-value was 8.14, which is significant at the one per cent level of confidence Therefore, it is evident that some difference in vocabulary achievement between the boys and the girls of some group or groups is statistically significant The means of the vocabulary scores were adjusted on the basis of the regression of vocabulary on *IQ* and separate analyses were made of the differences between the adjusted vocabulary means of the boys and the girls of each group. The only *t*-value of significance obtained was in the Articulation-Disability Group in which *t* is 2.13, which is significant at the 5 per cent level of confidence. In the other groups the vocabulary performance of the boys is not significantly better than that of the girls Furthermore, abundant evidence from previous investigations has shown that sex differences in vocabulary are usually inconsistent and unreliable in school age children Therefore, it is possible that the significant sex difference in vocabulary found in only one of the groups in this study is due to random variation

G. Language Development

One of the areas in which articulation- and reading-disability cases have rarely been measured is that of oral language usage And yet, language development is generally considered to be related to articulatory and reading ability E A Davis (10) states that "Although not all the differences are statistically reliable, the evidence is so consistent as to make it extremely probable that faulty articulation tends to retard language development through the kindergarten years" (p 40) Furthermore, in acknowledging the importance of language development for reading, Betts (7) says that· "proficiency in oral language is one prime prerequisite to readiness for initial reading instruction" (p 307). Therefore, in the present investigation the experimental subjects were measured in mean length of response, complexity of grammatical structure, and completeness of sentence as shown in samples of oral conversation.

1. *Method of Securing Responses*

For securing the samples of oral language, Rosensweig's Picture-Association Study for Assessing Reactions to Frustration (33), in the preliminary form specifically designed for children, was used. This projective technique consists of 32 pictures similar in form to the comic strips of the newspapers and one picture was added for the present investigation. This activity was most appealing to the children and little difficulty was experienced in obtaining responses. An occasional child had to be coaxed to respond with more than one word and so the first eight pictures were used for practice and the responses to these were excluded in the final analyses. It was very easy in practically all of the cases to record all of the subject's words because this technique conveniently spaces the responses more than the usual presentation of toys would do.

2. *Group and Sex Differences in Length of Response*

In scoring the length of response the method devised by McCarthy (25) and generally followed by investigators in this field was used. Beginning with the response to the ninth picture, the number of words in 25 responses was counted. Table 9 presents the means and variability of the groups with respect to the mean length of 25 responses. An analysis of covariance of *IQ* and length of 25 responses was undertaken in order to equalize the effect of intelligence from group to group and between sexes. Inasmuch as the obtained *F*-values between groups (0.03) and between sexes (0.01) are

TABLE 9

MEANS AND VARIABILITY OF THE GROUPS IN LENGTH OF 25 RESPONSES

	Control group	Articulation-Disability group	Reading-Disability group	Reading-Articulation-Disability group	All groups
Number					
Boys	58	33	27	21	139
Girls	16	9	8	6	39
All	74	42	35	27	178
Mean					
Boys	121.74	119.82	115.30	116.48	119.24
Girls	113.06	130.11	110.00	121.17	117.62
All	119.87	122.02	114.09	117.52	118.88
SD					
Boys	28.87	33.51	27.13	27.19	29.60
Girls	27.20	41.86	50.34	24.62	37.14
All	28.74	35.72	33.94	26.71	31.41

obviously insignificant, there is no need for separate analyses of group or sex differences. It may be concluded that the groups and sexes in this study are not significantly differentiated by mean length of response

3. *Complexity of Response*

Most investigators have described the complexity of grammatical structure in terms of the percentage of simple, complex, compound, and elaborated sentences. Williams and McFarland (39) gave arbitrary weights from zero to four for unintelligible, simple, complex, and compound-complex responses. Because percentages are inter-dependent, the following quantitative system of scoring was devised for use in this study after careful evaluation of the factors comprising complexity and their relationship to language development:

		Score
(*a*)	A response which has no meaning; not functionally complete	0
(*b*)	A response that is functionally complete but grammatically incomplete, an element which has recognizable meaning but does not have the structure expected for expressing a complete thought	1
(*c*)	An infinitive . .	1
(*d*)	A prepositional phrase .	1
(*e*)	A compound predicate	1
(*f*)	An independent or coordinate clause (simple, interrogative, or imperative sentence, or each independent clause in a compound sentence) .	2
(*g*)	A dependent or subordinate clause	3

4 *Group and Sex Differences in Complexity of Response*

Table 10 presents the means and variabilities of the groups with respect to complexity of 25 responses as measured in this study The group means show a slight superiority of the Control and Articulation-Disability groups and the sex differences are inconsistent In order to make due allowance for group and sex differences in *IQ*, the covariance procedure was again used Inasmuch as the obtained *F*-values (0 02 and 0 00) are obviously insignificant, neither the groups nor the sexes are significantly differentiated by complexity of grammatical structure. Although the group means vary in the expected direction, the variability is so great and the differences so slight that they are not statistically significant with the number of cases involved in this study.

TABLE 10
Means and Variability of the Groups in Complexity of 25 Responses

	Control group	Articulation-Disability group	Reading-Disability group	Reading-Articulation-Disability group	All groups
Number					
Boys	58	33	27	21	139
Girls	16	9	8	6	39
All	74	42	35	27	178
Mean					
Boys	60.26	58.64	57.93	57.67	59.03
Girls	58.19	61.22	54.13	61.00	58.49
All	59.81	59.19	57.06	58.41	58.91
SD					
Boys	9.34	11.57	10.90	10.17	10.40
Girls	10.79	12.85	15.32	8.43	12.31
All	9.71	11.90	12.16	9.90	10.85

5. *Group and Sex Differences in Completeness of Response*

As a last measure of language development the 25 responses of each subject were classified with respect to grammatical completeness. The means and variabilities of the groups according to completeness of response are presented in Table 11. There appears to be little variation in the means of the groups, but the boys of the Reading-Disability and Reading-Articulation-Disability groups appear slightly superior to the girls with respect to completeness of

TABLE 11
Means and Variability of the Groups in Completeness of 25 Responses

	Control group	Articulation-Disability group	Reading-Disability group	Reading-Articulation-Disability group	All groups
Number					
Boys	58	33	27	21	139
Girls	16	9	8	6	39
All	74	42	35	27	178
Mean					
Boys	21.24	21.33	21.63	21.76	21.42
Girls	21.00	21.56	19.13	19.83	20.56
All	21.19	21.38	21.06	21.33	21.23
SD					
Boys	3.36	3.83	3.07	2.29	3.42
Girls	3.92	3.92	7.24	3.13	4.79
All	4.49	3.85	4.51	3.36	3.78

response. It is probable that this variable is of less importance at the eight-year level than in the preschool years. In order to make appropriate allowance for *IQ* differences, the covariance technique was used Since the *F*-values between groups and between sexes (0 05 and 0.17) are of no statistical significance, it may be concluded that neither groups nor sexes are significantly differentiated by completeness of response

H INTER-RELATIONSHIPS OF LINGUISTIC FUNCTIONS

Since one of the purposes of this study was to find the relationships among the various linguistic functions measured in each of the carefully selected experimental groups, coefficients of correlation were determined by the Pearson product-moment method for each variable with every other variable Not only were these correlations computed for each experimental group as a whole, but also for the boys alone of each group because of sex differences in linguistic functioning Inasmuch as the number of girls in each group was small, no separate correlations were undertaken for them alone. The coefficients for the boys and girls combined are in close agreement with those for the boys alone Therefore the following discussion will be confined to consideration of the correlations shown in Table 12, which are based on the total number of cases in each group

In the interpretation of these correlations the experimental design must be recalled Since the proportion of boys to girls was kept constant from group to group, comparison of the correlations of the groups is justifiable. The boys outnumbered the girls 3½ to one in each group This disproportionate sex difference is representative of populations of articulation and reading-disability cases However, because of this disproportionate sex distribution and the speech and reading disabilities of the subjects, these groups are not representative of a normal population This fact must be borne in mind when comparing these correlations with those obtained by other investigators

Because of the homogeneity of the groups with respect to age and mental ability, most of the obtained correlations are small It should be remembered, therefore, that greater heterogeneity in age and intelligence of subjects would probably increase the magnitude of the correlations between many of the variables Hence, all coefficients reported probably should be interpreted as minimal estimates of the true correlations between the variables involved.

In correlating oral reading with the other variables two different systems of scoring were employed In the Control and Articulation-Disability groups,

TABLE 12
COEFFICIENTS OF CORRELATION OF LINGUISTIC FUNCTIONS

	Control group $N = 74$	Articulation-Disability group $N = 42$	Reading-Disability group $N = 35$	Reading-Articulation-Disability group $N = 27$
IQ and				
Articulation errors	——	062	——	—154
Oral reading†	275*	371*	—260	—026
Silent reading	415**	367*	283	—058
Vocabulary	417**	451**	486**	618**
Length	.221	076	047	.005
Complexity	221	.062	.046	—060
Completeness	115	175	—105	139
Articulation errors and				
Oral reading†	——	167	——	—298
Silent reading	——	—015	——	.002
Vocabulary	——	—074	——	153
Length	——	—103	——	268
Complexity	——	—077	——	259
Completeness	——	—067	——	061
Oral reading† and				
Silent reading	.737**	785**	—440**	—072
Vocabulary	164	439**	—.389*	—238
Length	—.086	107	—131	194
Complexity	—029	060	—282	146
Completeness	—136	229	—230	209
Silent reading and				
Vocabulary	324**	.433**	503**	—075
Length	016	.206	263	—025
Complexity	015	.188	.321	194
Completeness	—024	.173	071	—063
Vocabulary and				
Length	.196	—246	.287	075
Complexity	211	069	247	077
Completeness	.173	080	—032	.021
Length of response and				
Complexity	881**	.929**	910**	883**
Completeness	602**	684**	650**	539**
Complexity of response and				
Completeness	646**	744**	703**	.631**

†The correlations for oral reading for the Control and Articulation-Disability groups are based on scores showing positive reading achievement The correlations for oral reading for the Reading-Disability and Reading-Articulation-Disability groups are based on error scores showing negative reading achievement.

**Significant at the one per cent level of confidence

*Significant at the five per cent level of confidence.

it was necessary to use oral reading error scores in computing correlations. Therefore, positive correlations between oral reading and the other variables indicate positive relationships in the Control and Articulation-Disability groups, but negative correlations between oral reading and the other variables indicate positive relationships in the Reading- and Reading-Articulation-Disability groups.

Significant coefficients of correlation were obtained between the following variables in this study (*a*) *IQ* and oral reading in the Control and Articulation-Disability groups; (*b*) *IQ* and silent reading in the Control and Articulation-Disability groups, (*c*) *IQ* and vocabulary in all groups; (*d*) oral reading and silent reading in the Control, Articulation- and Reading-Disability groups, (*e*) oral reading and vocabulary in the Articulation- and Reading-Disability groups, (*f*) silent reading and vocabulary in the Control, Articulation- and Reading-Disability groups, (*g*) length and complexity of response in all groups, (*h*) length and completeness of response in all groups; and (*i*) complexity and completeness of response in all groups.

A few differences in correlations were apparent but not statistically significant The relationship of *IQ* to oral and silent reading was significant in the Control and Articulation-Disability groups but not in the Reading- and Reading-Articulation-Disability groups Since the reading achievement of the reading-disability cases showed little relationship to their intelligence, the specificity of their disability is emphasized

Oral and silent reading were significantly related in all except the Reading-Articulation-Disability Group The lack of consistency in the performance of the two types of reading tasks in the Reading-Articulation-Disability Group may have resulted from the articulation defect, which may impede oral reading more than silent reading

Except in the instances mentioned, the correlations were similar in all of the groups. It may be concluded that the relationships between most of the functions measured were generally the same for these children whether or not they had articulation and/or reading disabilities.

I. Conclusions

The results of this study of second-grade children have shown that children with functional articulation defects are significantly inferior in both oral and silent reading to children with normal speaking ability Furthermore, children with reading disability frequently have articulation defects The existence of this strong relationship between these two handicaps shows that either they result from a common cause or that articulatory defectiveness has a deleterious effect upon the development of normal reading ability

Although children with articulation and/or reading defects are not significantly retarded in vocabulary, they tend to be inferior to normal speakers and readers in vocabulary development This deficiency may have an unfavorable influence on the development of speech and reading or may be concomitantly caused

The implications of these findings present a challenge to educators Greater emphasis should be placed on the training of children in speech, vocabulary, and oral language usage before instruction in reading is begun. Children who have attained satisfactory command of articulation, vocabulary, and oral language not only will be more capable of making satisfactory progress in reading, but also will be better able to make more adequate personal and social adjustments

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ADJUSTMENT PROBLEMS AT UPPER EXTREMES OF TEST "INTELLIGENCE": CASES XIX-XXVIII*

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A.

Purported measures of "intelligence" have now been in clinical and educational use for something over a generation. During this period there has been a closer definition of what tests described under the name could reasonably be expected to do. Language has always had a dominant part in this material. On the special demands on abstracting power which are made by language as such, rests a major claim of such tests to be regarded as tests of intelligence. As the word is generally used, intelligence denotes far too broad a function to be assessed by language or any other means of like order. But language tests have satisfactorily proved themselves as criteria of abilities for dealing with ideas, sometimes directly spoken of as "abstract intelligence."

That qualities such as these carry no warrant of successful adjustment to social environments, has probably been known to insighted persons of all times. It required but little experience with these more quantified methods, to disclose that proficiency in them is little if any safeguard against the penal institution or the mental hospital. Meanwhile, as this measurement of intellectual qualities became a mass technique, its methods became much more stylized, thus further narrowing the areas of mental function which they tapped, though they could be expected to do their special tasks more effectively. But the further this stylizing process was carried, the less adequate the individual procedures became as attests of general adjustment level, or of the quality of intellect itself.

The cases to be reviewed in this presentation are selected to illustrate adjustment difficulties of various sorts in the presence of specially high capacities in the area of abstract intelligence. The principal criteria of these capacities are (*a*) the verbal and mathematical sections of the Scholastic Aptitude Test of the College Entrance Examination Board, here known respectively as *SAT* and *MAT*; (*b*) a test which is substantially the "Multi fied Alpha" of the Psychological Corporation, but used in various alternate forms; (*c*) a vocabulary range test based on O'Connor's "Worksample 95." The "intelligence tests" in common use clinically do not reach high enough to be especially serviceable at levels here concerned. They could be refined to this extent, but it is doubtful if this would add materially to what is already available through projective techniques, especially Rorschach.

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The present group of cases is a highly specialized one, that only rarely comes within the purview of clinical psychometrics This is a reason for the *ad hoc* nature of certain procedures employed. It is not practicable in this setting to describe these in detail. In large part it must suffice to identify the procedure by name and the general functions which it is intended to assess thereby. A condensed form of case presentation is used, to permit a wider conspectus of the material. The available information varies greatly It is comparatively full in the Grant Study cases (with which the present paper is concerned), though the problems in these cases are naturally much less interfering (cf. 2, Heath and Gregory). As of this presentation, the median age of the group is about 27 years. In the remainder, essentially Hygiene Department referrals, information may be at times limited to the referral data, with the psychometric work and its discussion. In most cases however, at least a subsequent academic record is available. The regular form in this paper is to cite the available data on (*a*) the problems observed in the above study by Heath and Gregory, and other supporting adjustmental grounds for inclusion in this series, in part the uniform Soundness Class of *C* (1, p. 20); (*b*) such information as is available on earlier history; (*c*) the immediate observation, with (*d*) special psychometric reference (where practicable, test scores are given in terms of sigma distances from current mean; e.g., ".5σ high," or ".3σ low," or "+ 5σ," "—.3σ"); (*e*) any subsequent data, and/or general comment.

The Grant Study case series is currently being reviewed by the staff with reference to prognosis for areas termed, personality integration; health, general medical; health, vascular, health, mental; longevity; family establishment and integration; social relationship; occupational achievement, economic status The rating steps used are here denoted by the terms *A* = *outstanding, B* = *very good, C* = *good average, D* = *low average, E* = *inferior.* These terms are chosen with reference to a general college population. The mean of the Grant Study selection might be expected to fall between the *very good* (*B*), and *good average* (*C*) of such a population. Inferior would denote the range opposite to *outstanding* plus *very good.* For the several cases, current prognostic ratings are as in Table 1.

TABLE 1

Case	XX	XXI	XXII	XXIII	XXIV	XXV	XXVI	XXVII	XXVIII	III	XII	13D*
Personality Integration	E	C	C	C	C	D	D	C–	C	C	D+	C
Health, General Medical	B	B	C	B	B	C	D	C	C	D+	B	B
Health, Vascular	B	B	C	C	B	D	B	B	B	C	C	B
Health, Mental	D	C	D	C	C	D	D	C–	C–	C	D	C
Health, Longevity	B	B	B	B	B	C	A	B	B	B–	B	B
Family Establishment and Integration	D	C	C	C	D	C	C	D	C	C	C	C
Social Relationships	D	C	D	D	D	D	C	D	C	D	D	B
Occupational Achievement	B	D	B	D	D	C	D	C	B	B–	C	B
Economic Status	C	D	D	D	D	C	D	D	B	D	D	B

*Cf Wells, Woods (8, p 230)

In these data, the Longevity of the present group is rated somewhat above the generality; no deviation from generality is apparent for General Medical and Vascular Health, and Occupational Achievement. Lower ratings attach to Personality Integration and to Mental Health (practically by definition), also to Social Relationships, and to Family Establishment and Integration Economic Status rates lower than Occupational Achievement, because Economic Status is rated on an absolute scale of predicted earnings, and the occupations predicted for these men are such as have, in our culture, a comparatively low economic "ceiling"

The nearest control for the present data is a group of Grant Study cases selected for similarly high psychometric status, but with Soundness classification of *A*. There are 21 such cases, two of whom have figured in previous presentations. It is implicit in the *A* and *C* classes that the "problems" (Heath and Gregory, 2) in the *A* class should be less exigent than those in *C*. Actually in four of this *A* group it was not practicable to cite any overt adjustment problems. There is also a qualitative difference. In the present *A* group the difficulties take most frequently a form of shyness, social "inferiority feelings." These qualities are syntonic, accept the group norm. Such are scarcely if at all mentioned for the present *C* group, where the problems have typically a more schizoid cast; e g , rigidity, overformality, parent-hostility, surface over-confidence masking insecurity.

How far this difference would carry through the less high intellectual levels of the *A* and *C* Soundness classes, it is not now possible to say No reason is apparent why lowered psychometric status, within the present brackets, should affect it. Further control is available through Hygiene Department referrals as already mentioned, embodying more difficult adjustment problems in the presence of like psychometric status. These data await further organization.

From the "intelligence test" standpoint the main interest centers on the relationships of verbal and quantitative capacities These vary among the individuals, in the manner shown in previous case presentations There is nothing to distinguish the *A* and *C* groups in this respect, though the extreme disparity (of some 4.5σ in *SAT/MAT*) occurs in the *C* individual already described as Case XII. In the trend of standard scores for the two groups (*SAT*, *MAT*, alpha-verbal, alpha-number, vocabulary range) nothing approaches a significant difference for the *A* and *C* groups. Mean alpha scores for the two are identical. Any of the patterns here concerned may be associated with any of these degrees of "soundness"; though they affect the way in which this soundness, or lack of it, is manifested.

As regards the development of various Rorschach categories, similar conditions obtain As such, the present *A* and *C* groups are not differentiated in this way More detail on the individual cases XIX-XXVIII is given below. For a very synoptic view there are cited for the present *A* ($N = 21$) and *C* ($N = 12$) groups, the extreme numbers in certain Rorschach categories, as in Table 2.

TABLE 2

	Max		Min			Max		Min.	
Function	*A*	*C*	*A*	*C*	Function	*A*	*C*	*A*	*C*
Response number	44	43	11	16	Color-Form	3	3	0	0
Wholes	16	22	3	5	Color	4	4	0	0
Details	40	37	8	1	Animal	23	19	2	5
Human Movement	11	6	0	0	Animal Detail	9	7	0	0
Animal Movement	5	10	0	0	Human	6	8	0	0
F plus	28	29	5	6	Human Detail	6	7	0	0
F minus	10	9	0	0	Object	8	12	0	0
Form-Color	4	3	0	0	Anatomy	7	4	0	0

Absence of White Space, in both groups, is notable. Such observations give support to the often and strongly asserted need for a configurational standpoint in the evaluation of Rorschach and allied material.

There follow the case summaries XIX-XXVIII. Case XIX is *offered* for comparison, as a Class *B* individual whose problems, while of syntonic variety, were rather pronounced for Class *A* The remaining *C* cases not cited in previous papers are nine in number, and show a wider range of reaction types than the larger A group above, ranging from the "outstandingly" Just-So, Inarticulate, Pragmatic XX to the Sensitive Affect, Verbally Facile, Creative-Intuitive developing mystic that is XXII; from the Autonomically Unstable, Sensitive Affect, Ideational XXVI to the Mood-Swing, Self-Driving, *Asocial "fighter" personality* of XXVIII; from the Pragmatic, easy-going, needing (though able-) to-be-driven, Lack of Purpose and Values XXI to the schizoid, Asocial, Cultural, *Unconforming* Purpose and Values of XXVII.

B.

1 *Case XIX*

a. Difficulties observed in this man include overdependence on parents; *socially underactive except at relatively ideational levels* (e.g., public speaking); rapid and pronounced mood swings, sleep habits not well organized; inferiority feelings centered around social inadequacies, with resentment against those better equipped *b.* Is second of six children, marginal economic circumstances. Antecedents, including parents, are mentally well organized (much respiratory disease), intellectually undistinguished, in striking contrast to the present sibship, all of whom appear intellectually superior to the antecedents, some equal to the present case. Numerous pre-college academic distinctions, little athletic participation. Good pre-college employment record.

c. Body-build dominantly mesomorphic, endo- and ectomorphy equally reduced. Deviates from this type psychologically in the direction of cerebrotonia; *e.g.*, abstemious in alcohol, tobacco, and "dates", intolerance of noise; motor and social awkwardness. On the other hand, likes people (typifies the Grant Study usage of "Shy"). Markedly negative reaction to demands of armed forces service. Assigned Outstanding Traits: Unstable Autonomic Functions, Basic Personality Highly Integrated (?I) (cf. 8, 137, 173, 187; 7, Case XVI), Dominance of Mood, Sensitive Affect, Self-Driving, Inhibited, Selfconscious-Introspective, Verbal Facility, Shy, Social Science Motivations, Human Values, Lack of Purpose and Values. The Verbal Facility is of the cerebrotonic type elsewhere distinguished (5), as is exactitude of word choice.

d. On a sigma basis, test ratings include *SAT* (scholastic aptitude, verbal) +1.7; *MAT* (scholastic aptitude, mathematical) +2.4. Alpha verbal, +1.2; subtest order, Analogies, Directions, Opposites, Mixed Sentences. Alpha number, +2.6; subtest order Arithmetical Reasoning high, others bracketed well below. Vocabulary range, +1.00. Easy Block Assemblies, +.81; difficult Block Assemblies, +.84.

From a projective standpoint (Condensed), Rorschach response number was practically group average, but with Wholes some 1.5σ in excess. Percent of F responses about average for the group, but $F-$ nearly equalled $F+$. Movement and Color were fairly balanced, distinctive features being absence of Animal Movement and overdevelopment of texture response. Plant responses were outstandingly prominent in the content, Populars well represented, but little originality or organization, by present standards a record of average richness only.

Handwriting analysis (3) agrees better than average with criterion, chief departures being to overestimate self-assertion and to underestimate intellect. It picks up the mood swings and a series of other viscerotonic features hitherto rather masked in this presentation ("personable, careful about appearance and clothes, friendly, sympathetic; extraverted, likes a good time, influenced by pleasure impulses").

e. Subsequent college career was in the highest brackets academically, otherwise undistinguished. The earlier adjustment problems have now largely disappeared, possibly through maturation, possibly through the different demands of adult life. Varied aptitudes led to some difficulties in career planning, but general idea of advanced work in (relatively) pure science, balanced socially through teaching; and with emphasis on family stability rather than personal repute. War demands turned the effort into more technological channels to which adjustment was made without difficulty. The work resembles that of the Physical Science Motivations individuals elsewhere observed (6), but differs importantly in that research interests are not reported Later work, though still in industry, has swung more in the direction originally planned, similar intellectual demands but greater social contacts. Somatotonic components continue in the background, for all the mesomorphy, but the general adjustment, including marriage, is recorded as a now very satisfactory one

2 *Case XX*

a. In this case, an extreme rigidity and over-formality, though not subjectively sensed as such, were here looked upon as predisposing to adjustment difficulties, apparently not without justification

b. Is older of two children, economic circumstances a little better than those of the previous case Information on antecedents comparatively full, indicates a level of abilities somewhat closer to that of this man, though not in the case of the parents who appear distinctly less able Nowhere in the antecedents are the very superior intellectual talents evident, or the unusual temperamental qualities Active secondary school athletic participation, moderate employment history. No particular scholastic distinction reported pre-college, though the record must have been good

c Dominant body type again mesomorphic, more pronouncedly so than in XIX, endomorphy and ectomorphy equally reduced. Psychotype more clearly somatotonic, distinction in contact athletics Viscerotonic and cerebrotonic components nearly absent as concerns overt conduct ("no warmth or variations of mood"), though much is made of a repressed "hard aggressiveness", also of a trend towards claustrophobia In parallel to this is a Kempfian "catabolic plus" temperament, the somatotonic intolerance of inaction is reported in thoughts running faster than his hand, making for difficulty in writing.

Beneath this somatotonic surface is a highly developed imaginative life, that would not come to ordinary observation, and on which even these intensive studies testify to presence rather than to influence on conduct.

Along with the overt and typical "semantic rigidity," fondness for the exactness of mathematical reasoning, there has been active fantasy and even interest in the occult. There is thus psychiatric evidence for a deep cleavage *in this man's mental make-up: "a curious streak . . . which he will not* (cannot?) express . . . may well have a deep interest in speculative thought. He is so impatient in his thought that he cannot be satisfied with slow methods of deductive thought" Thus according to the history, the mesomorphy and somatotonia are sitting on the lid of a very dynamic "unconscious."

Assigned Outstanding Traits: Basic Personality Highly Integrated, Bland Affect, Just-So, Ideational, Inarticulate, Asocial, Pragmatic Again the concept of Highly Integrated makes trouble. A degree of internal consistency in patterning, however maintained, seems to be the highest common denominator of its meanings.

d. Sigma ratings of tests: SAT +.7, MAT +.83. Alpha verbal +1.2; among subtests, Same-Opposites distinctly low. Alpha number +1.9; subtests relatively undifferentiated. Vocabulary range —.1, the order of accomplishment in these three verbal functions decrease with the increase of the cultural factor.

The Rorschach figures readily tap the imaginative activity above mentioned. In the face of the Inarticulate rating, a response of the highest richness rating is elicited. Number is only average, and there is weighting on the Detail side, the strength lies in Movement, Originality, and Organization. Color is less developed as such but appears to stimulate productivity in Movement. (Block Assemblies are undistinguished.)

Handwriting analysis picks up the features represented by the above Outstanding Traits of Bland Affect, Just-So, Asocial, Pragmatic. It does more justice to the scientific interests. Neither appears to do justice to the underlying fantasy life, but the handwriting appraisal comes near to the best agreement with the history, found in the entire series.

e. College career of Dean's List grade, almost wholly scientific and technological. War Service technological, as with other individuals in this general series where scientific aptitudes and interests were prominent Career plans consistent, and singularly uncomplicated. The earlier imaginative life may have receded. Domination of values by scientific, intellectualist trends, and conscious endeavors to make the rest of his life instrumental thereto ("spiritual avitaminosis"). Consequent difficulties of adjustment in other areas.

3. *Case XXI*

a. At the time of observation, special problems present in this man concern lackadaisical attitudes, failure to live up to potentialities, dissipation of energies, "laziness," alcohol.

b. Economic status superior, among the highest in the total series. This derives from abilities of the father, socially and professionally active and successful. Mother of average interests and accomplishments. Antecedents well adjusted but of no comparable abilities. Superiority to other children in early school contacts developed certain leadership tendencies, frustrated in later, more competitive school environments. Some reactive difficulty, shyness, "snobbishness." Afterwards more athletic participation with better acceptance (cf. 4, Case I). Sibs may have intellects on a par with this man's, but accomplishments interfered with, now by impulsive, perfectionist traits, now by too easy-going attitudes. In this man pre-college athletic participation slight, non-competitive, no employment history; recreational activities such as normal for given socio-economic status.

c. In somatotype a slight preponderance of mesomorphy, other components equal but generally subaverage development. Otherwise, body-build had special evidences of female and dysplastic features. Temperamentally, viscerotonic traits appear uppermost, with somatotonia rather in the background. Cerebrotonic features included over-reaction to venipuncture, social inhibitions with an over-rigidity and formalism in test situations. Physiologically, *a schizoid type of spirogram.*

Assigned Outstanding Traits: Basic Personality Less Integrated, Practical Organizing, Pragmatic, Lack of Purpose and Values. It is not easy to reconstruct on what the second of these is based. The chief values concern immediate and personal satisfactions, this is the Pragmatic attitude in essence, but the behavioral expression seems at this time hardly vigorous enough for the Practical Organizing assignment, though the later history would better justify it.

d. Test ratings include *SAT* +.55, *MAT* +1.46, alpha verbal +.46, analogies and directions subtests especially high, same-opposites and mixed sentences especially low. Alpha number 1.9σ high, all subtests about equally high, except computation which is at mean. Vocabulary range is actually —.37. Block Assembly tests, easy and difficult, +.64 and +.73 respectively. This psychometric profile approaches a "natural" for motivations in physical science or technology, which are conspicuous by absence.

In the face of the Pragmatic assignment, the Rorschach pattern is weighted towards Wholes as over 4:1; the average proportion in this material being nearer 1:1.6. There is no Movement, human or animal; color score would be 2. Animal is to human response as 8.1. Form level is below par, not only as to *F*—, but as to content as such without definite shape. A notable contrast to the precisionist psychometrics; e.g., not a single error in the outstanding alpha number work. A Strong Vocational Interest Profile gives *A* scores for psychologist and lawyer respectively; lowest scores cluster in the business-industrial area.

Handwriting analysis agrees rather well with the criterion as then set up, overestimates "cheerfulness, self-confidence, ease of adjustment." The viscerotonic components are well picked up. By the available data it overestimates energy (would have justified Practical Organizing), agrees with the criterion fully in regard to the Pragmatic components.

e. Subsequent academic career was hardly on a par with the psychometric promise, still slightly above average. Of interest for later developments is the following extract from a progress note, written without knowledge of the war record: "He does have the Lack of Purpose and Values of a rather spoiled scion of a wealthy family, but one can detect under this a fairly stable and middle of the road nature. . . . Lack of strength of personality as a sophomore may result more from lack of opportunity than a basic personality characteristic."

War Service active and not undistinguished, with promotions in the commissioned grades. Would have been in the Award group (8) if the information had been available. Own accounts denote excellent service adjustment and maturation of attitudes. One may note that the handwriting analysis denoted a stronger personality than appeared then to exist and which became overt in the war situation.

Is thus reminiscent of Cases III, IV, "palimpsest personalities" in whom a basic strength had been overlaid by a masking environment. In this case the better analogy may be to the form of writing mentioned in Poe's "Goldbug," which appears under heat and fades when heat is withdrawn. Some hint that with return to civilian life the former less vigorous behavior patterns are returning.

4. *Case XXII*

a. The problems are chiefly in the social area, specifically those implicit in a heavily cerebrotonic temperament.

b. The youngest of three children, economic status well above want, but permitting few luxuries. Antecedents show considerable ability, now in business, now in artistic directions, the average economically somewhat above this man's father In the father, cultural interests and accomplishments well developed, but less effectively capitalized. Mother less cultural, more social and domestic No positive difficulties with childhood adjustments, but general motor ineffectiveness led to self-isolation from companions Trend toward literary creativity and ideational concerns generally in early adolescence, in part reactively motivated. Vacations recreative, no record of remunerative work.

c Body-build heavily ectomorphic with minimal endomorphy and a fair degree of mesomorphy. Within this body type a "well balanced somatic structure." Psychotype is consistent, asociality to the point of studied self-isolation had been noted, other features are vocal restraint and general intolerance of noise, motor awkwardness (cf. XIX), special sex inhibitions Is a good demonstration of the assets as well as liabilities summed up in Kempf's corresponding Anabolic-minus/Catabolic-minus class.

Assigned Outstanding Traits numerous, and fairly implicit in the above. Basic Personality Highly Integrated, Dominance of Mood, Sensitive Affect, Selfconscious-Introspective, Cultural, Creative-Intuitive, Verbal Facility, Asocial, Lack of Purpose and Values. The mood swings denote an important feature, apparently associated with marked rises and falls of intellectual power The Verbal Facility is written rather than oral. Ideational life on the side of "semantic flexibility", thus the record: "He does not like the restricted quality of thought necessary for delving into historical points of fact, or chasing down the meanings or use of words own flair is for expression and for as unorganized and unsystematized expression as possible" On the other hand "the mathematics and science he did have to take came fairly easy. . "

d. *SAT* +1 8, *MAT* lacking. Alpha verbal +1.3, analogies subtest relatively weak; alpha number +.2, but relatively strong in the reasoning and series completion subtests Vocabulary range +1. Block assemblies reflect the motor awkwardness against good insight; easy —.7, difficult +1.4. Rorschach response number slightly plus; pattern weighted clearly on *W* side. About average *M*, no color response, corresponding excess of Form, but some excess of *F*—, both Animal and Human response are in over 2 1 excess, no Object response; Originals reduced. Richness rating is *C*+; does not reflect the active intellectual life elsewhere described

Handwriting analysis, comparatively little agreement with criterion; e g., "typical extravert, . . . emotional and impulsive . . do well in administrative or minor executive work . " Principal agreement as to "some imagination, might make use of it in a literary way . . . inferiority complex . . shrinks."

e. College grades in highest brackets, all "liberal arts" topics. Overt social adjustment somewhat less difficult; but subjectively, continuing schizoid attitudes.

During a long period of war service, the general conditions were such as to permit, if not to foster, a considerable spiritual growth This appears to have fairly neutralized the schizoid features, at least as they denote negativistic social attitudes. Interest in creative work continues, but has been considerably spiritualized. He may easily have the makings of an American C. S. Lewis. The failure of the above projective evidence to pick up these tendencies is marked.

5. *Case XXIII*

a. The problems concern difficulties with social contacts of all sorts, to a special extent in the immediate family; also general instability of motivation, as with career plans.

b Third of four children, family of slightly above marginal economic status. Record of antecedents markedly emphasizes sociophilia; one grandparent only somewhat in the direction of this case, average economic level probably higher. Sibs much more adaptable socially than this case, one showing fair literary talent. Earner from early age, sharing readily with family. Appears more sociophilic at this time. Near puberty an introversive change reported, less motivated and effective socially. History negative for mechanical interest or ability; inferior motor coordination.

c. Body-build fairly balanced with slight emphasis on endomorphy; high "feminine component" in physique. At time of observation, personality pattern more consistent with ectomorphy, no exercise, social reactions of all sorts greatly reduced, accepts rôle of social isolate, notably lacks social considerateness. Sex inhibitions; one of those in whom it is difficult to "give or receive affection." Would classify as a Kempfian *A*—, *C;* diminished capacity for building up tensions, fairly vigorous and rather overready reactions. Thoughts run too quickly for good formulations; overspeeding brings errors in precise work.

Another of the "semantically elastic" group; avoids scientific studies; feels temperamentally unadapted to rigorous thought; "neither patience nor precision for objective and systematic thinking." Assigned Outstanding Traits: Unstable Autonomic Functions, Basic Personality Less Integrated, Dominance of Mood, Sensitive Affect, Selfconscious-Introspective, Cultural, Asocial, Lack of Purpose and Values.

d. Only in alpha number among the fixed answer tests, does this case show the upper extreme that would ordinarily be associated with a place in the present group; relative to general population it is still at the upper extreme and may be included for other problems that it poses. *SAT* and vocabulary actually about 4σ low. *MAT* similarly high, alpha verbal $.54\sigma$ high. Subtest profile shows Directions test over a sigma below the others. This is consistent with the reported negative reaction to "precise thinking", less so is the alpha number score of $+1.9\sigma$. This, with the consistent though less markedly high *MAT* gives evidence of capacity notably out of line with attitudes. On the other hand, the comparable lack of spatial aptitudes is reflected in Block Assemblies, easy -37σ, difficult -1.8σ, the converse of Case XXII.

Rorschach response number about a sigma low, but richness grade is high, offsetting modest grades in verbal multiple choice. Weighted about 1.3 on the Detail side. Movement predominates heavily over Color. Form level about average, but *F*'s reduced in number, a trace, but only a trace, of White Space. Human responses about twice as frequent as local average in relation to Animal. Card VI refused and in general the cards were given up after short intervals. Responses had more thematic quality than is usual, apparently representing intrapsychic conflicts at no great depth.

Another of the cases helping to make up the generalization that less integrated individuals show less graphological agreement with the criterion. Sociophilia is by handwriting rated as highly positive; with a practical rather than the abstract mind found in the criterion. On the other hand the existence of conflict is picked up, and there are agreements in various details. In both this and the previous case the script was rated sociophilic against a contrary criterion; but this is on the whole the personality feature where the analyses show the greatest agreement.

e. This man's subsequent college work was of Dean's List grade. While in not quite the highest brackets it is somewhat better than the test ratings. Extracurricular participation was minimal. Later developments are of special interest as representing a return towards the sociophilia of the early years. The work in the armed services was comparable to that of Case XII, with whom he shares many of the Outstanding Traits, though psychometrically they are opposed. It is difficult to regard the nature of the war experience as an essential factor in the change. XII moved towards somatotonia, XXIII towards viscerotonia. For Sheldonians, one could point out that in XXIII this direction is that of the body-build, for graphologists, it is the direction of the handwriting analysis. The change described is more than the normally easier adjustment of the cerebrotonic to adult life in the local culture. Schizoid components still remain in the personality, but are clearly subordinate The last accounts are of generally satisfactory adjustments, especially including the areas of parents and sibs, career and sex. One is left with the problem of the schizoid shifting in early adolescence; it has a not far from malign aspect until early adulthood and subsequent restoration of earlier patterns. Adequate psychodynamic factors are below the level of the present psychiatric observation.

6 *Case XXIV*

a This man presented no problems on his own account, and the most objective statement concerns special tensions in various fields, e.g., fidgetiness, elaborated by such general expressions as need for "getting hold of self", for "self-understanding."

b. Social background first rate, economic resources somewhat less than ordinarily associated with it, not inadequate. Father a very competent and socially superior civil engineer; mother with some artistic accomplishment Comparatively meagre information about antecedents, alternates between variously superior attainments and marked adjustment difficulty. Sibs present a similar picture.

Man himself is third of four children. As in Case XXIII, record of *early sociophilia, which in this case at a much earlier age swings into marked* shyness diminishing at time of these observations Family very close-knit, note possible hindrance to socialization (7, Case XVII). Early school work erratic, in part reactive to these social insufficiencies, some active fantasy life similarly motivated. Afterwards steadier in these respects; also a good pre-college employment record.

c. Body-build fairly balanced, ectomorphy somewhat less developed Trait picture includes marked vocal and postural "restraint"; "inhibited social address," and though "resistance to habit and poor routinizing" do not appear, rather the contrary, the configuration is clearly cerebrotonic. Assigned Outstanding Traits: Bland Affect (in this case probably a function of effective masking), Selfconscious-Introspective, Physical Science Motivations, Shy. Scientific interest rationalized on an aptitude basis. This case would qualify in the area already represented by Cases IX, X.

d. *SAT* runs nearly 1σ high; *MAT* over 2σ high. Verbal alpha 1.2σ high, the Directions items trailing markedly among the subtests. Number alpha 2.1σ high with relative excesses in the Arithmetical Reasoning and Number Series Completion subtests Vocabulary range comparatively low, +.5σ The three verbal tests improve as the cultural factor diminishes, the two quantitative are substantially equal. The scientific concerns are not picked up by the Block Assemblies. With one of the easy, an anomalous failure is recorded, and the difficult score but .18σ high.

The history might lend itself to considerable *M* in Rorschach. *M* and *C* categories actually show about equal and average development. Response number a sigma low, considerably weighted on the side of Wholes All Form responses "plus." Only other notable departure from local average, superior development of Organization

e. During the college course this man is recorded as gaining considerably in sociality and confidence, the academic work, though concentrated in the chosen field, was well below the level of psychometric findings War service, essentially technological, as is usual for this type of participant. Graduate career proceeding along similar lines. Like the undergraduate work however it does not yet seem up to potentialities indicated psychometrically, or realized in Cases IX and X This is not readily accounted for on a test basis, strong and weak points are irregularly distributed among them. Projective work is in favor of IX and X, though its relevance is problematical

7. *Case XXV*

a. Although (or because?) this man was apparently the least "integrated" of those here discussed, it was difficult to cite more specific problems. Feelings of insecurity masked by surface overconfidence, emotional sensitivity masked by "logical, analytical, positive and factual" appearance, inhibition of usual accomplishment drives, are cited clinically, but little subjectively sensed.

b Is the younger of two children, in a family of "upper middle" status. The father, on basis of slight formal education achieved substantial professional status, with various cultural interests Parents rather resemble each other in energy, competence, health, and marked satisfaction in their lives In the father's parents some "intrapunitiveness", the mother's rather more aggressive, collaterals vary, but not outside normal limits and about a healthy mean.

In early life got on well with other children without depending on them, generally contented, with some "stubbornness" This independence created in the family and in school something of a disciplinary problem. Need for attention seems also to have been a factor. For early age, family allowed considerable discretion in money matters, apparently never abused. Athletic participation rather above average through the years, with normal social participation in college. Vacations wholly recreative. Always much closer to father than to mother.

c. In body-build markedly mesomorphic with ectomorphy in the background. As in XXII, considerable dysplasia and "feminine component." Psychotype relieves the present monotony of cerebrotonic preponderance; the loose integration of the personality appears in such temperamentally opposed tendencies as heavy sleep, but inhibition under alcohol, the (above) surface overconfidence, "boastfulness," even rebelliousness, masking a need for security and avoidance of risks; the surface "logicality" and inhibition of emotional expressions, masking a relative touchiness.

The complexities of this personality render it peculiarly unsuited to representing in the schema of Outstanding Traits. Those actually assigned are limited to Basic Personality Less Integrated, Ideational, Lack of Purpose and Values, and any additions from the series would be misleading.

d. *SAT* is .9σ high, *MAT* 1.4σ high. Alpha reverses this order, verbal $+1.4\sigma$, number $+.7$. Verbal subtests are singularly constant, number subtests close to mean except addition, 1.4σ high. Vocabulary, .2σ high; easy block assemblies close to mean, difficult 1.4σ high. At the time, the high verbal alpha appeared more representative of the mental alertness, *SAT* being limited by low word-knowledge. The number alpha score is not that *of outstanding quantitative aptitudes, despite the achievements represented* in *MAT*.

Rorschach response is of interest as consistent with a healthier pattern than is implicit in the above account. W/D ratio is average. Considerable *M* with some excess of Animal movement; contents are aggressive. Form level is excellent. Color practically absent, cf. the "logicality" above. Human responses in relative excess of Animal. Good development of Originals, Populars and Organization.

The handwriting account is psychiatrically labelled "good." Only one disagreement with criterion, attributing a greater amount of "poise" for one "so emotionally charged" (minimal Rorschach Color!). In especially apt accordance with the history, "He is sociable without being sympathetic or devoted . . . lack of self assurance in spite of the bluster shown superficially."

Lack of Purpose and Values should be represented by absence of high scores in the Strong or Kuder type of inventory. A Strong schedule accomplished by this man yielded no ratings above B+; these were under Personnel and Advertising Man. Lowest scores were for *CPA* and Purchasing Agent.

e College grades fairly up to indicated aptitudes in his chosen field; elsewhere mediocre. Fair extracurricular participation. Objective data on subsequent career accord with the favorable picture in some of the projective responses, and rather discount the misgivings earlier expressed. Professional training completed, and a career satisfactorily begun, in an area disparate from undergraduate work, and rated *C*+ by the Strong schedule

The Lack of Purpose and Values ascribed to this case was not so much a matter of motivational asthenia as a delay in focusing energies which were amply present Undefined Purpose and Values would have been a more precise formulation.

8. *Case XXVI*

a Tendency to emotional overreaction characterized the problems of this man, both as presented by him and as otherwise evident to observation. Anxiety, depression, disturbed dreams cited as more specific manifestations.

b. Is the last of four children in a household of marginal economic status. Parents of good cultural level, but diffuse interests, and underaggressive On the other hand, very good use of available resources, other sibs have achieved college training. They are generally intellectual and "high-strung", similar factors appear in the paternal antecedents.

Dominating the personality picture is an early social interest, expressing itself in a teaching career plan, developing on a broad, not to say inflated base. Some aesthetic interests and accomplishments Intellect described as clearly verbalistic (for both oral and written expression), rather than quantitative. Little or no difficulty in social adaptation, making friends easily as a child, later described as good mixer; good pre-college earnings; good but again diffuse social service and athletic participation in college.

c. Somatotype gives an equal and considerable preponderance of ecto- and mesomorphy over endormorphy Even for this material, psychotype here observed shows comparative weighting with cerebrotonic features; as inhibited speech, low voice, sleep difficulties (with characteristic late relaxation), motor tensions, fidgetiness Mood swings and a turning to people when troubled are viscerotonic features. On the somatotonic side is the degree of athletic participation (while discussing sports is said to be boring), and the good reaction to such physical discomforts as were observed, e g, venipuncture; though the same could not be said for mental stresses Assigned Outstanding Traits are Unstable Autonomic Functions, Sensitive Affect, Selfconscious-Introspective, Ideational, all of cerebrotonic bearing

The schema hardly does justice to the sociality of this man, which falls between the present meanings of Sociable and Social Science Motivations, but as above, it is well developed

d. Contradictory evidence is presented by the verbal and quantitative test response. *SAT*, $.5\sigma$ high, verbal alpha 1.2σ high; the *MAT* scores —8 and number alpha +2.4, among the highest observed. Subtests are fairly equal, save for deficiency in Same-Opposites. This may be associated with the moderate vocabulary, +.6. There is evidence for a marked quantitative aptitude that has not been exploited, for lack of motivation. This aptitude does not extend to spatial functions; the easier block assemblies score +1.5, but the difficult, —.9.

Rorschach response number, about $.7\sigma$ high, the pattern carries an excess of Color over Movement (no Animal movement); especially good form level; marked excess of Human detail; otherwise no clear departure from local averages.

Bernreuter scores are less extreme than might have been looked for from the history. The N(eurotic) and I(ntroversive) are close to mean, S(elf-sufficiency) tending towards high, D(ominance) tending towards low. The S(ociability) and C(onfidence) *scores* are higher, the former at least, is opposed to the social motivations recorded; suggests conflicts in this area, as does in less degree the Self-sufficiency score. Otherwise the profile is consistent with the history, though its features are less marked.

e. Social service interests were actively continued, though in subsequent contacts here, a more reserved bearing was noted. Academic status consistent with test level reported. Graduate career along contemplated lines, with natural interests in counseling as well as class-room work. Some original work of rather ingenious scholarship in which the quantitative aptitudes previously mentioned, appear to have some part The "Unstable Autonomic Functions" have persisted, and been a limiting factor in health A life philosophy in fairly explicit detail is recorded in consonance with the above career motivations, by no means as spiritualized as in Case XXII, and more socially oriented, but with a similar general direction.

9 *Case XXVII*

a This man was somewhat critical of the upbringing he had been given, feeling that his parents had not given him a proper degree of direction. From the standpoint of immediate observation, schizoid traits to a degree characterized in the record as "ominous"

b. Second in a family of four, whose socio-economic status seems the least favorable in this series. Father is a skilled technician, "genial, dependable" but underaggressive. Mother shows the domestic and sociophilic traits normal to the group. Father's father and mother appear as very capable persons at middle class level, mother's father and mother recorded as similar but not quite equal. Until this generation no marked intellectual traits save in an aunt, otherwise maladjusted. Present sibs all intellectually capable, others more socialized than this man, stock at present on the upgrade.

As small child aloof and reserved, fussy and possessive over belongings. Interests in ideas rather than people, liking to work alone, unusually independent of help, special preference for working through difficulties himself. Technological interests and competence manifested at preschool age. Various food idiosyncrasies. As an adolescent a very competent technician, at much more advanced level than father, but minimal social or athletic participation. Despite asociality, did his share in a well-functioning family unit. Fair pre-college employment record.

c. Despite poor muscle tonus and general lack of conditioning, lasted the full five minutes on the treadmill, building up the good lactate of 150, pushed self hard. Somatotype not outstanding, meso-, ecto-, and endomorphy in that order. Speech tended to monotone, even when dealing with topics of marked affective value. A noteworthy feature in his history was a capacity to shift interests from one object to another, human or technological, almost in the manner of throwing switches. A marked degree of fancy life, tending indeed to dissociative features, is described (cf. XX). In early adolescence social attitudes such as to provoke hostility, not without pleasure therein. In fancy at least this could involve punishing self, to reach those who would be hurt by it (cf. psychodynamics of suicide).

The assigned Outstanding Traits seem to overstress the ideational to the cost of technological interests and capacities. They are, Basic Personality Less Integrated, Selfconscious-Introspective, Ideational, Cultural, Asocial, Lack of Purpose and Values. As already remarked, this last may in the present case be looked on as not so much a lack as a trend to unusual objectives.

d. *SAT* +1.0, *MAT* +2.1. Alpha tests show a substantial equality for verbal and quantitative at $+1.0\sigma$. *MAT* excess appears distinctly as motivational, alpha test evidence is insignificantly for superior verbal aptitude. But vocabulary range is only +.2. While the easy Block Assemblies are 1.0σ high, the difficult are actually $.2\sigma$ low.

Rorschach response number is negligibly above local average, but richness is good. It is somewhat, not greatly, weighted on the Detail side. Movement is greatly in excess of Color, as it should be. $F+\%$ is about 85. There is a greater excess of Animal over Human response than is usual for the group. Also rather unexpected are a good average of Popular responses, and an absence of White Space

Graphological analysis is not available, general impression of the script is disorderly for one of such intellectual competence. From a descriptive standpoint a recent script embodies. Pressure, light. Size, medium. Form, tends slightly to round. Spacing, horizontal, extended. Spacing, vertical, normal. Baseline, descending; varies markedly within words. Slant, right. Connections, normal. Ovals, tendency to overclosure. Zones, normal. Terminal strokes, variable Capitals, relatively small. *t* bars, medium height; mostly to right of stem, normal length, ascend, not hooked. *i* dots low, mostly to right.

Certain common factors in this case and the following XXVIII (*q.v.*), lend interest to the close parallelism of the Bernreuter scores Either profile could have been given by the other, so far as the trait-names go; an important difference might be expressed in a greater robustness of personality for XXVIII, and the differences are critical for what an inventory type of approach will and will not pick up. In XXVIII the high Dominance and Self-sufficiency are more securely based; in XXVII they have a rather reactive and compensatory character. The different career types entered by the two, are to be noted in this connection.

e. Course work of Dean's List grade. Minimal extracurricular activity, minor social participation.

War service again technological and career developing at a professional level along these lines Overtly satisfactory adjustment in all major areas. Sociability seems to continue well below average, and the life philosophy to be more egoistic than the average of the present cases, approaching, though hardly equalling, Case XX in this respect.

1. *Case XXVIII*

a. This man's problems expressed themselves largely on a superego level; self-discipline to accord with moral standards; related to these, a somewhat unrealistic attitude towards family responsibilities. Pose of superiority, mood swings.

b. The socio-economic background is upper middle; father businessman, "solid citizen," with cultural interests. Mother a vivacious personality, with considerable intellectual talent, now masked by the usual social and domestic concerns. Antecedents have been variably integrated but within normal limits; no indications of special talents as present in this man. Sibs also vary greatly in personality type, some resemblance to this man, including similarly high intellects.

As a small child, shyness and sensitivity, some fears, food idiosyncracies. High intellect remarked early, high inquisitiveness; this plus the shyness may have issued in a self-sufficiency also early noted. Early feelings of athletic inferiority, disappearing with developing proficiency. Also with maturation, a growing competitive spirit, great energy output, persistence, perfectionism. Markedly active in secondary school, football, debating, general social life.

Mathematical interests as far back as memory reaches (a hobby of this sort in the father's history, probably no longer active in this man's childhood). Considerable early mechanical interests, good at work with hands. Good pre-college employment record.

c. Body-build heavily mesomorphic, record cites as "all bone and muscle." Medium endomorphy, minimal ectomorphy. Observed psychotype corresponds; the only cerebrotonic features observed appear a cultural overlay. The athletic pattern (treadmill run full five minutes to lactate of 164), reactions to trouble and pain are clearly somatotonic, blending with viscerotonia occurs in respect to food and social habits. The mood-swings observed would go with more endomorphy.

Certain of the assigned Outstanding Traits need explanation. In all, they are Basic Personality Highly Integrated, Dominance of Mood, Self-Driving, Inhibited, Ideational, Asocial, Social Science Motivations. The first three are understandable, especially in the light of post-observational history. The remainder have meanings rather special to this case. The "inhibitions" are those of a strong superego. The ideational life is a function of the high intellect, has no escape connotations. The asocial feature is a function of capacity rather than tendency to do without. The Social Science Motivations represent a will to integrate the life of society into a philosophical schema, again are without escape significance. Also in view of the sequel, it should be observed that Physical Science Motivations is not recorded despite the aptitudes and by no means lacking inclinations.

d. *SAT* $+1.5\sigma$, *MAT* $+1.8\sigma$. Alpha verbal $+1.3\sigma$, with directions and mixed sentences subtests in the lead; alpha number $+2.4\sigma$, with little subtest difference, though arithmetical reasoning and highest common factor are in the lead. Vocabulary range, $+.9\sigma$. This is one of the highest configurations in the total series. Easy Block Assemblies, $+1.6\sigma$, difficult, $+.6\sigma$.

In Rorschach response, this is a case whose intellect would justify a good deal of *F*, and rather little *M* or *C*. There is no reason to anticipate any great swing to W or D, and none is found; what little there is, on the side of W. There is slight M, no Animal movement; about half the responses are Form, with a large excess of $F+$. There is considerable color, the score would be 6 ($R = 23$). This deviates somewhat from the objectivity, even "coldness" reported for the overt personality pattern, but might have a deeper connection with the mood-swings. At the time it was related to a hyperkinesis in the overt conduct.

Bernreuter scores are available for this man as noted under XXVII, and reflect very well the evidence of the history as a whole. Neurotic and Introversive scores very low, Self-sufficiency and Dominance scores very high. S score again very high ("independent"), C score low (good self-confidence). No such inventory could be asked to "ring the bell" more clearly than this. Picture-story response illustrates one of the simpler interpretive pitfalls. Manifest content is one of frustration, tragedy, defeatism; in the light of subsequent history, the figures involved can hardly be understood otherwise than as objects of aggressions in the narrator

e. Subsequent college career showed much (contact) athletic participation, and a varied extracurricular life Academic grades were high, language rather than scientific courses being the rule. Armed services participation notably effective, in both combat and non-combat functions, highly commendatory ratings and verbal expressions being on record from superiors. In the words of a recent staff note, "A very self-sufficient leader of men . . . a perfect bear for punishment during the war . . . came out of it with a great deal of accomplishment . . . easy, fluent talker . . . stage of sorting out his beliefs and ideals intending to intellectualize them." It is pertinent to recall that the basis on which this individual was selected, was as among the "least sound" personality type in the total series.

Post-war career plans are professional, in a verbal-social area.

C

In conclusion, brief comment may be made on the manner in which these specific cases fit certain generalizations as to body-build, Rorschach functions and the like While the Sheldonian temperament categories have been very satisfactory, deviations from somatotype are not absent. In XXIV, a less developed ectomorphy is associated with a principally cerebrotonic temperament. In XXV, the marked mesomorphy rather fails of its psychological counterpart. In XX, XXII, XXVIII, major temperamental features accord well with somatotype.

In mentally exceptional individuals such as these, one must not expect similar departures from average in antecedents (including parentage), or descendants, for that matter Notable deviation from antecedents occurs in XX, XXIII, XXVII. The antecedents of XXIV, XXV, and XXVIII would give more ground to expect the special abilities that they themselves show. Of interest are the superior sibships encountered on a more modest antecedent base, as in XXVI and especially XXVII; though the rôles of genogenesis and psychogenesis cannot here be assessed

Among the critical Rorschach features of this material are (*a*) the low form level in XIX and the paucity of Form responses in XX, both of whom are technologically oriented and competent. (*b*) In XXI the excess of Wholes against a Pragmatic rating, and the high excess of Animal responses in one of such intellectual status (*c*) The substantial absence of White Space response in the relatively "oppositional" XXIII and XXVII (*d*) The heavy excess of *C* and its excess over *M* shown by XXVIII, although in most of these cases the traditional rôle of *M* . *C* has been fairly sustained XXVI should have had more full Human as well as Popular response, and less Human Detail

A further word on the recurring theme of Aptitude × Motivation. In the cases here summarized there is a tendency for quantitative scores to be higher than verbal On the other hand, Physical Science Motivations was assigned in but one case (XXIV), though it could have been justified for XXVIII also Relation to ensuing careers is complicated by technological motivations of the war. XXIV naturally pursues a technological career, in the war and since But XXVIII, with a closely similar setup, did not do technological war work, and now follows a verbal-social career In the remaining seven cases, in whose test aptitudes the quantitative outweighed the verbal, XIX, XX, and XXVII follow a technological career, but only XX and XXVII are clearly motivated towards it. Nor can appeal be taken in this material at least, to the spatial factor This tends to positive for cases XIX, XXI, XXII, XXVII, XXVIII, and of these five, XXI, XXII, and XXVIII are in verbal careers. The spatial factor tends to negative for XX, XXIII, XXIV, XXVI, and of these four, two are in technological careers In XXI and XXVIII, aptitudes were especially stacked towards science or technology; both are in verbal careers, with no account of career maladjustment

There is nothing in the types of careers these men have entered, to distinguish them from the Study group as a whole. The Prognostic ratings previously cited give the present appraisal of the adjustment outlook within these careers, and for life as a whole These ratings are not yet made for enough participants to afford other than tentative comparisons. In the medical areas, as well as those of occupational achievement, they are certainly not rated lower than the group as a whole. In the areas of personal and social integration the ratings are generally less favorable, and in conformity with the types of adjustment problem differentiating this group at the time of original observation.

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THE EFFECT ON SUBSEQUENT MAZE LEARNING ABILITY OF GRADED AMOUNTS OF VITAMIN B₁ IN THE DIET OF VERY YOUNG RATS*[1]

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A INTRODUCTION

Vitamin B_1 is essential for the proper growth and function of nerve tissue. It is well known that a deficiency of vitamin causes beriberi, a disease which is characterized by lesions in the nerve tissue of various parts of the body with consequent pain and loss of muscular control Because of this connection with the nervous system psychologists were not slow to see the possible importance of vitamin B_1 in the field of physiological psychology. However, it was not until around 1940 that pure vitamin B_1, or thiamine, became available for psychological research Before that time crude and unsatisfactory methods were the only ones at hand for the control of B_1 in an experimental diet

At first the chemistry of the vitamins was so little understood that psychologists experimented with the entire *B* complex rather than with any particular member like B_1 (2, 6). Siegfried Maurer in 1935 was probably the first to single out vitamin B_1 and to study its relationship to a psychological function (7). His conclusion was that maze learning ability in the white rat depends to a large extent upon the presence of sufficient B_1 in the diet. Others supported his opinion (9, 10, 11, 12).

But the evidence was far from conclusive The principal impediment in the way of progress was the practical impossibility of obtaining the vitamins in purified form. In 1936 vitamin B_1 was selling, if at all available, for $8,000 an ounce. So long as the pure vitamins could not be obtained, experimental animals could not be subjected to specific deficiencies and the conclusions from all experimental work had to be correspondingly vague and qualified. It was also impossible to study the effect of an excess amount

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of vitamin B_1 in the diet, a topic which promises to be even more interesting than the consequences of a B_1 deficiency

About 1940, when chemically pure vitamin B_1 (thiamine) became available at reasonable prices, psychologists began to apply the new tool to many types of psychological problems, such as, the effect of a thiamine deficiency on the rat's ability to learn a conditioned response (3), its effect upon the rat's susceptibility to convulsive seizures (8), and the effect of excess thiamine on various mental traits in children (4). The effect of thiamine on maze learning seems to have been overlooked; perhaps the tedious inconclusive experiments of the preceding decade had made this a wearisome topic. The reason why these were inconclusive will be explained later in more detail, but in general it was because they used the inadequate methods of the period to control the vitamin content of the diet. Today, thanks to the chemists, it is possible to raise rats on a synthetic diet in which the amount of the *B* vitamins is exactly controlled Only thus is it possible to determine the effect of vitamin B_1 on the rat's ability to learn a maze

In the present experiment chemically pure vitamins were used. For the various treatment groups the amount of B_1 in the diet was the only variable, ranging from a severe deficiency to a great excess. These rats, raised on an experimental synthetic diet, were compared with a control group which had received a completely normal rat diet, in order to determine the effect of vitamin B_1 on maze learning ability.

B. RESULTS OF EARLIER EXPERIMENTS

Siegfried Maurer was active in this field almost from the very beginning, his earliest articles go back to 1930 (6). He was probably the first to state definitely that the vitamin *B* complex and especially B_1 have a potent influence on learning ability An experiment reported in 1935 involving more than 200 rats may be taken as a good summary of his work (7) The experimental group of animals received an inadequate supply of vitamin B_1 from birth until the age of 45 days, but the animals were not deprived entirely of the vitamin. The nursing mothers were fed an artificial diet containing yeast which had been autoclaved for five hours at 20 lbs. pressure This process destroyed the thermolabile B_1; however, it is now known that other thermolabile *B* vitamins, such as pantothenic acid, are also destroyed by such treatment (13) When the nursing females lost a certain percentage of their weight, they were given untreated yeast to keep their weight constant. Maurer found that the experimental group was significantly inferior to a control group when both were tested in a Carr maze. He came to the definite conclusion that a B_1 deficiency in the diet of very young rats reduces their maze learning ability. But this conclusion cannot now be accepted as final inasmuch as other *B* vitamins were also missing from the experimental diet

In 1934 Bernhardt reported the results of an experiment in which he deprived young rats of the entire *B* complex during the nursing period (2). In the control groups the nursing females received a synthetic diet containing yeast to supply the *B* vitamins, in the experimental group the mothers received the same synthetic diet but without yeast and otherwise free of the *B* vitamins For these two groups then the only difference in diet was the presence or absence of yeast which is a rich course of the *B* complex In the learning tests two types of problem were used, a maze and a multiple choice situation, escape from water was the incentive in both tests Bernhardt found that the vitamin deficient animals were significantly inferior to the controls From this experiment it is impossible to draw any specific conclusion regarding the effects of vitamin B_1 since the experimental diet was deficient in the entire *B* complex

From 1936 to 1939 Poe, Poe, and Muenzinger published the results of a series of experiments on the relationship between the vitamin *B* complex and maze learning in white rats (9, 10, 11, 12) The final experiment was a repetition and summary of all the preceding (12) In this study four groups of animals were used One was the control and received a normal rat diet, while the other three were raised on a basal synthetic diet which lacked all members of the *B* complex This diet consisted of purified casein, cornstarch, a salt mixture, cod liver oil, and butterfat In order to add vitamin B_1, the diet was supplemented with an alcoholic extract from 50 grams of wheat for every 100 grams of food mixture To supply vitamin B_2, 10 grams of autoclaved liver were added for every kilo of food mixture One experimental group received only the basal diet, lacking both B_1 and B_2, a second group received B_1 without B_2, the third had B_2 without B_1 The differential diet began at the age of two weeks by regulating the diet of the nursing female during the last week before weaning, it continued after weaning until the pups were seven weeks old at which time testing began on a pair of short water mazes During the entire testing period, all the rats received the normal rat diet The results of this experiment showed that all the experimental groups were inferior to the control by every measure of learning and all of these differences were statistically significant The group which lacked both B_1 and B_2 had the poorest scores of all; the B_1 deficient group was inferior to the B_2 deficient group

Poe, Poe, and Muenzinger conducted these experiments at the very time when great discoveries were being made in the chemistry of the vitamins. In 1936 Williams and others worked out the structural formula of and synthesized vitamin B_1 (13). By 1940 it was possible to obtain all the known members of the *B* complex as pure chemicals at reasonable prices. From that time on research workers could state exactly the vitamin content of synthetic diets The work of Poe, Poe, and Muenzinger is undoubtedly the classic of the earlier period but it is now open to fundamental objections B_1 and B_2 are not the only members of the *B* complex as these authors believed (12, pg. 212). An alcoholic extract of wheat contains other *B* vitamins besides B_1 because the entire group is somewhat soluble in alcohol; autoclaved liver lacks not only B_1 but all the thermolabile *B* vitamins (13). Therefore the work of Poe, Poe, and Muenzinger offers no valid basis for specific conclusions regarding the effect of B_1 on maze learning ability.

After 1940 psychologists adopted the newer methods and used thiamine, the pure chemical form of vitamin B_1, to study its effects on human and animal behavior (3, 4, 8) Apparently Lush was the only one to use the new method to attack the old problem of the effect of B_1 on maze learning (5). She found that thiamine had no effect on maze learning ability, but this negative result is probably due to the fact that the rats in her experiments were not subjected to the thiamine deficiency at a sufficiently early age. The present writer began the controlled diet at six days after birth and found that the gradient for maze learning ability follows the gradient of the thiamine content of the diet. By using pure thiamine, it was also possible to show that an excess of B_1 in the diet improves maze learning ability above normal.

C Experimental Procedure

Eight groups, each consisting of 18 animals, were used in this experiment Every group was subjected to a different type of diet in preparation for the tests of learning ability. These treatment groups are designated by the Roman numerals I to VIII.

The first five groups from I to V, were raised on a synthetic diet which lacked the entire vitamin *B* complex. Each day, as a supplement, four members of the *B* complex were added in exactly controlled amounts. B_2, B_6, and calcium pantothenate were added in excess, namely 20γ of B_2, 20γ of B_2, and 40γ of calcium pantothenate a day for each rat. The symbol γ (pronounced gamma) means microgram or a millionth of a gram. The daily quota of B_1 differed for each of these groups. Every rat in Group I received 2γ of vitamin B_1 a day; these in Group II, 3γ; Group III, 4γ, Group IV, 6γ; Group V, 10γ. The vitamin supplement was presented to each animal in a separate glass dish mixed with enough dextrine to form a paste. The animals never failed to consume the entire supplement Since the rats were kept in separate cages, no rat could eat the food intended for another.

Group VI was the control group. All the rats in this group were raised on a normal rat diet consisting of ingredients which occur naturally Group VII also received the normal diet but with a large excess of vitamin B_1 added to the drinking water, namely 5γ of B_1 per cc of water. Group VIII was raised on the synthetic diet with an excess of all the *B* vitamins mentioned above, namely 5γ of B_1, 5γ of B_2, 5γ of B6, and 10γ of calcium pantothenate per cc of drinking water On the basis of sample records of the amount of drinking water consumed, it was estimated that these rats in the excess vitamin groups received between 100γ and 200γ a day of B_1

The normal rat diet which was used in this experiment is sold commercially as Fox Blox It is used exclusively at the Albino Farms, Red Bank, New Jersey, and produces large healthy rats. The synthetic diet consisted of vitamin-free casein (30 parts), crisco (5 parts), cod liver oil (3 parts), sucrose (57 parts), and Osborne and Mendel salt mixture (5 parts). This particular synthetic diet has proved satisfactory in the bio-chemistry laboratories at Fordham University It may be taken for granted, therefore, that all the rats received an adequate diet except for the differential amounts of B_1. An abundant supply of food was left in the cages at all times. However, since a thiamine deficiency causes a loss of appetite, the thiamine deficient animals consumed much less than the others

Of the 18 rats in Group I, no two were from the same litter, this is true for all the groups from I to VI. The 18 rats in Group VII were from 10 different litters; those in Group VIII were from 12 different litters Consequently, each group may be regarded as a random sample from the large rat population at the Albino Farms; in this way hereditary differences were randomized No difficulty was encountered in the process of interchanging the rats from different litters; the nursing mothers accepted all indiscriminately Six rats were assigned to each female for nursing

The controlled diet for each treatment group began when the pups were not more than six days old The nursing females received the diet which was proper for the treatment group to which the pups belonged but after weaning at 21 days of age, each rat received the proper diet of its own group. At the end of the eighth week after birth, the differential diets were discontinued and from then on all rats received the same natural rat food as the control, Group VI. In this way the underweight vitamin-deficient animals gained weight and strength before the maze trials began Table 1 shows the average weights of the treatment groups at the beginning and end of the experimental diet. That the controlled diet produced real differences in weight between the groups, is indicated by a Fisher *F* value *of 27.08, which is reliable well above the one per cent level of confidence.*

TABLE 1
AVERAGE WEIGHT IN GRAMS OF THE 18 RATS IN EACH TREATMENT GROUP, AT THE BEGINNING AND THE END OF THE EXPERIMENTAL DIET

Age	Treatment groups I	II	III	IV	V	VI	VII	VIII
1 week	*11.8*	*12.0*	*12.2*	*12.2*	*12.2*	*12.1*	*11.9*	*12.2*
8 weeks	80.2	98.5	108.4	113.6	134.1	150.9	11.6	125.5

A battery of three water mazes was used to measure learning ability. These mazes are the same as those used by Poe, Poe, and Muenzinger (44) and by Bernhardt (3). The two mazes used by Poe, Poe, and Muenzinger are short and each contains four choice points, in the present experiment these mazes are designated Maze *A* and Maze *B*. The maze used by Bernhardt is longer and contains eight choice points; in the present experiment it is designated Maze C. The rat was left *in the maze for two minutes and if* by that time it had not yet reached the escape runway, the effort was counted as one trial. The criterion of learning was four errorless trials out of five Each rat received five trials a day; as soon as the rat mastered one maze, it was given a three-day rest and started on the next maze All rats began the series of three mazes in the *A, B, C* order, at the end of nine weeks after birth Since the differential diet ended at the eighth week, all the animals had one week of normal diet before beginning the maze tests Records were kept of the total time and the number of trials required to reach the criterion of learning and the total number of errors committed during the trials

D ANALYSIS OF RESULTS

The results of the maze tests, recorded in Table 2, indicate that learning ability follows the gradient of the thiamine content of the diet, more thiamine leads to greater learning ability. *In Maze A, the thiamine deficient groups* were the slowest learners, the excess thiamine groups were the best, while the control group held the middle position However, this pattern is clear only in Maze *A*, it is not evident in Mazes *B* and *C*. This is a difficulty which will be discussed later on. With reference to Maze *A*, the first maze

TABLE 2

AVERAGE LEARNING SCORES IN MAZES *A*, *B*, AND *C* OF THE 18 RATS IN EACH TREATMENT GROUP

Measure of learning	Treatment groups I	II	III	IV	V	VI	VII	VIII
				Maze A				
Total time (minutes)	19.1	18.9	14.0	14.0	14.6	13.4	9.4	10.1
Number of trials	18.0	18.4	15.4	14.4	14.8	12.9	11.2	11.6
Number of errors	80.4	73.9	57.2	58.3	62.7	51.2	35.7	36.4
				Maze B				
Total time (minutes)	3.3	5.2	4.5	5.1	3.2	2.9	4.1	3.4
Number of trials	8.8	12.9	9.9	12.0	8.8	7.8	8.9	7.4
Number of errors	9.9	15.0	12.2	13.6	10.1	7.8	10.5	8.6
				Maze C				
Total time (minutes)	7.9	6.1	5.9	7.3	4.7	6.2	8.3	6.6
Number of trials	13.3	10.4	10.0	12.1	10.1	10.2	11.4	10.4
Number of errors	36.8	29.0	24.4	31.4	21.4	26.7	34.9	27.8

to be learned, the Fisher *F* test indicates definitely that there are real differences in maze learning ability between the various treatment groups. The *F* values for the intergroup differences on the three measures of learning ability are all above the one per cent level of confidence (Table 3) The thiamine content of the diet, therefore, does influence learning ability.

This is especially true for the extreme dosages of thiamine, whether it be a severe deficiency or a great excess Slight thiamine differences in the middle of the range have little effect on learning ability To show this more clearly, the scores of adjacent groups were combined for statistical analysis Group

TABLE 3

THE FISHER *F* RATIO

For the intermean differences between the eight treatment groups, on three measures of learning in Maze *A* These values for *F* indicate real differences between the groups above the 1 per cent of confidence.

Measure of learning	Fisher *F* value for the intermean differences
Total time	4.19
Number of trials	3.43
Number of errors	4.81

I which received 2γ of thiamine daily and Group II which received 3γ were combined statistically as one group. Groups III and IV (4γ and 6γ of thiamine daily) were combined, Group V (10γ daily) and Group VI, the control, were taken together. The excess thiamine groups, VII and VIII, were also treated as one group.

Between these four combined groups, the thiamine differences are larger and so are the differences in learning ability. The learning scores for the combined treatment groups are given in Table 4. The *F* values for the four groups show that there are real differences between them in learning ability, reliable at well above the one per cent level of confidence (Table 5). Every measure of learning shows that more thiamine in the diet leads to better learning scores

Table 6 gives the intermean differences between particular pairs of combined treatment groups, together with the reliability of these differences as measured by the *t*-test. It will be noticed that the two middle groups (III-IV and V-VI) are about equal in learning ability; the differences between them are small and unreliable statistically. On the other hand there are large reliable differences between these two middle groups and either extreme group. From the physiological standpoint, the minimal requirement for normal physical growth in the rat, is about 10γ to 20γ of thiamine daily (1). Groups I-II, therefore, suffered a severe deficiency, 2γ and 3γ a day, Groups VII-VIII received a great excess of the vitamin, 100γ to 200γ a day. This

TABLE 4

AVERAGE LEARNING SCORES IN MAZE *A* OF THE 36 RATS IN EACH COMBINED TREATMENT-GROUP

Measure of learning	Combined treatment-groups I & II	III & IV	V & VI	VII & VIII
Total time (minutes)	19.0	14.0	14.0	9.8
Number of trials	18.2	14.9	13.9	11.4
Number of errors	77.2	57.8	56.9	36.1

TABLE 5

THE FISHER *F* RATIO

For the intermean differences between the four combined treatment groups, on three measures of learning in Maze A These values of F indicate real differences between the groups, above the 1 per cent level of confidence

Measure of learning	Fisher *F* value *for the intermean differences*
Total time	6.08
Number of trials	7.76
Number of errors	10.84

TABLE 6
INTERMEAN DIFFERENCES BETWEEN PARTICULAR PAIRS OF COMBINED TREATMENT-GROUPS ON THREE MEASURES OF LEARNING IN MAZE *A*

	III & IV	V & VI	VII & VIII
	Total time		
I & II	5.03**	5.03**	9.25**
III & IV		0.00	4.22*
V & VI			4.22*
	Number of trials		
I & II	3.27*	4.30**	6.83
III & IV		1.03	3.56*
V & VI			2.53
	Number of errors		
I & II	19.36**	20.25**	41.09**
III & IV		86	21.70**
V & VI			20.84**

*Indicates a difference which is reliable at the 5 per cent level
**Indicates a difference which is reliable at the 1 per cent level

indicates that a severe thiamine deficiency significantly weakens maze learning ability while a great excess of the vitamin raises it well above normal. A mild thiamine deficiency has no reliable effect on the maze learning ability of the white rat.

One other conclusion may be drawn from the data The drinking water of Group VII was enriched with thiamine at the rate of 5γ per cc , the drinking water of Group VIII was enriched not only with thiamine, but with other *B* vitamins, riboflavin, pyridoxine, and calcium pantothenate Nevertheless the learning scores indicate no reliable differences between Group VII and Group VIII. It may be concluded that when a rat is receiving an abundant supply of thiamine, an excess of the other *B* vitamins will not cause any further improvement in learning ability This suggests that in the *B* complex thiamine is the significant factor in regard to maze learning ability

Does the supply of thiamine in the diet influence maze learning ability merely because it affects the general physical health of the animal? A larger supply of thiamine in the diet leads to greater weight and presumably to greater strength for swimming the maze However, there is no significant correlation between weight and learning ability. For each treatment group taken separately, the weights of the animals when they began Maze *A* and their learning scores in Maze *A* were correlated and the correlation coefficients were all close enough to zero to be insignificant. Moreover the rats were all well fed on a normal diet immediately before and during the testing period There was no sign of weakness during the tests On the other hand it is well known that the amount of thiamine in the diet affects the growth and function of nerve tissue; beriberi is the result of a thiamine deficiency Hence it seems more logical to conclude that in this experiment thiamine affected maze learning ability because the very young rats received different amounts of the vitamin at the time when the nervous system was developing most rapidly

All of these conclusions are based on the learning scores of Maze *A*, Mazes *B* and *C* which the rats learned after Maze *A* did not indicate any reliable correlation between thiamine and learning ability Two explanations suggest themselves Either the thiamine-induced differences in learning ability were short-lived and wore off before the rats began Mazes *B* and *C*, or Mazes *B* and *C*, coming after Maze *A*, were too easy to bring out really existing differences between the groups On the basis of the evidence, it is impossible to decide whether one or both of these explanations is correct

However it seems clear to the writer that in this experiment Mazes *B* and *C* were too easy to bring out differences in ability even if they still existed. The learning scores show that the rats found Maze *A* much more difficult than the other two; and yet, judged by the number of choice points, Maze *C* was more difficult than Maze *A*. It seems clear that positive transfer aided the rats in learning Mazes *B* and *C*. All of the rats learned Maze *A* first In Maze *A* the rats had to swim about almost at random before they discovered that there was any escape runway; in Maze *A* the rats made 61 per cent of all their errors before they found the escape runway for the first time In Maze *B*, almost all the rats found the escape on the very first trial, in Maze *B*, only 8 per cent of the errors were committed before the first escape. This means that the nature of the problem had changed radically when the rats came to the second maze In Maze *A* they learned something which made subsequent water mazes much easier, they learned how to eliminate the first half of the learning period during which, in the first maze, they made 61 per cent of all their errors. The only conclusion which seems warranted from the scores in Mazes *B* and *C*, is that it was a mistake to use three water mazes in succession Perhaps some more difficult type of problem should have been offered to make a further test of the differences in learning ability which had been revealed in Maze *A*, the results from two additional water mazes are entirely ambiguous.

E Conclusions

1 The amount of thiamine in the diet of very young rats affected their ability to learn a water maze. Larger amounts of thiamine led to better maze performance.

2 A daily allowance of less than 3γ of thiamine diminished maze learning ability below normal, more than a 100γ a day improved maze performance above normal. The amount of improvement and impairment was statistically significant and reliable above the one per cent level of confidence.

3 Variations in the thiamine content of the diet between 3γ and 100γ a day did not produce any significant effect on maze learning ability.

4. When rats received an excess of thiamine, they did not make any further improvement in maze learning ability when large amounts of riboflavin (B_2), pyridoxine (B_6), and calcium pantothenate were added to the diet.

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SOCIAL FACILITATION OF FEEDING BEHAVIOR IN DOGS
I GROUP AND SOLITARY FEEDING*

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A. INTRODUCTION

Studies of social phenomena have been made on a large variety of species and in a great many ways. The need for a good understanding of these social relationships is of obvious and great importance in any approach to human behavior. The social factors influencing the behavior of animals towards food have been studied by several investigators. A review and analysis of some of these studies may be found in Katz (6). An excellent general review of the various studies on food habits has been presented by the Committee on Food Habits of the National Research Council (10). A general review, therefore, of the literature will not be presented Several significant studies having an immediate bearing on the present problem will be discussed below.

Katz's review (6) has reported some of the studies on social facilitation of feeding in such species as chickens (Bayer), rats (Harlow), goldfish, paradise fish, zebra fish, shiners (Welty), and monkeys (Harlow and Yudin). Katz has discussed all of the findings in terms of the satisfaction of needs as dependent upon the external circumstances (the field).

Bayer's work (1) on the social facilitation of feeding responses in chickens is of pioneer importance in the field Bayer found that a satiated hen ate 25-30 per cent more food in the presence of an actively eating hen, and 33-67 percent more with three actively eating hens. If three satiated hens placed with one eating actively, the effect was less—only about 10 per cent more being eaten The dominant hen always attacked the other hen, regardless of its condition of hunger or satiation When the hens were fed in a group of four one day and separately the next day, they would eat in the order of 96 per cent more food in groups The effects of social stimulation in the

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above study are complicated; however, some of the basic variables are manipulated.

Guhl and Allee (3) studied eating behavior, egg-laying, and weight gains in hens living in *stable flocks (with well-established peck orders), living in* isolated flocks, and living in constantly reorganized flocks These writers report that the hens living in isolation equalled those in the organized flocks in the three measures. The constantly reorganized flocks yielded significant changes in performance.

Harlow (5) investigated *the social facilitation of feeding in the albino* rat. He found that a satiated rat did not eat more in the presence of a hungry rat. However, group feeding (2-5 rats) in rats with no previous experience with solid food resulted in more food eaten per member when compared with an equated group feeding in isolation When rats had previously lived and eaten in groups (4-5 members), greater facilitation was evidenced in the quantity eaten when fed in pairs on alternate days Harlow drew several conclusions in regard to learning, constancy of the facilitation, imitation, "envy," size of group and age The essential condition for facilitation seemed to be the presence of rats *unrestrained* and *actively* competing with the other for food

Bayroff (2) studied the effect of early isolation on later social behavior in the white rat He reported only a few cases of consistent social preferences, while there were a great many cases of consistent position preference in the choice situation He remarks that active or participating animals may be necessary to demonstrate the social preference, although this condition may introduce certain effects of "aggressiveness."

Harlow and Yudin (5) observed social facilitation in almost all of the Macacus rhesus monkeys studied The degree of facilitation appeared to be a function of the active competition between the monkeys

Other studies have been made on food sharing behavior in chimpanzees by Nissen and Crawford (7). Nowlis (8) studied the relationship between hunger and the behavior of chimpanzees in different competitive situations. He reported on the effects of the dominance-submission relationship to food sharing in another study (9) Here a relationship was reported between dominance—as measured by food getting and escaping first from a small cage —and food sharing. The most dominant chimpanzee never shared and the most submissive chimpanzee never received food from him.

The various experiments mentioned above show the complexity of the eating situation for all organisms Indeed, as Katz (6) has put it: ". . . the effects of hunger are to a high degree dependent upon the external circumstances in which the animals find themselves." "The hunger impulse, therefore, does not rest on a merely physiological basis." In the present experiment an attempt will be made to study the effect of social grouping on feeding behavior in young dogs. Further reports will follow dealing with the effects of other variables.

B. Method and Procedure

The experiment was performed at the Division of Behavior Studies, Roscoe B. Jackson Memorial Laboratory, Bar Harbor, Maine, during the summer of 1947.

1. *Subjects*

The subjects for this experiment were 10 puppies from two litters of the laboratory colony.

The first litter was the F_1 generation resulting from a Chow (♀) and Basenji (♂) cross. The mother and father were mated at the laboratory, and the litter of four dogs was born on 16 April, 1947. The litter was wormed on 5 June, 1947, and was given an injection of liver *B* complex on the same day. The dogs remained with the mother until 18 June, 1947. In addition to nursing the mother, the young dogs were able to eat some milk and Pablum supplement on 26 June, 1947. Thus, the animals were born under laboratory control, and had contact mainly with the mother during the period preceding the experiment. The dogs were given laboratory identification numbers on 27 June, 1947, as shown in Table 1, with the sex and weight data.

TABLE 1

Number	Sex	Weight
494	Male	12 pounds, 2.8 ounces
495	Male	12 pounds, 15.5 ounces
496	Female	12 pounds, 3.6 ounces
497	Female	12 pounds, 15.6 ounces

The second litter was the F_1 generation from an Irish Terrier (♀) and a Dachshund (♂) cross. The mother and father were mated at the laboratory, and a litter of eight dogs was born on 21 May, 1947. Two of the eight puppies were destroyed, and three male and three female puppies were kept. The litter was wormed on 26 June, 1947, and each dog was given an injection of liver *B* complex. At this time the mother was removed from the litter. Thus, the subjects were born under laboratory control, and had contact mainly with the mother during the period preceding the experiment.

The dogs were given laboratory identification numbers on July 7, 1947, as shown in Table 2, together with sex and weight information.

TABLE 2

Number	Sex	Weight
505	Female	3 pounds, 15 ounces
506	Female	4 pounds, 7 ounces
507	Female	3 pounds, 9 ounces
510	Male	4 pounds, 10 ounces
511	Male	4 pounds, 14 ounces
512	Male	4 pounds, 3 ounces

2 *Diet*

The dogs were kept on the standard diet of the laboratory. This diet is made up of the following constituents:

Purina Dog Chow Kibbled Meal
Ground boiled horse meat.
Evaporated milk
Abbott's Haliver Malt and Viosterol.
VpC Vin-D-Mineral Supplement
Pablum

The meal constituted about 3/4 to 4/5 of the basic dry food. To the meal was added the horse meat, the Viosterol, the mineral supplement, and water. The food, when presented to the dogs, had a porridge-like consistency This food mixture was used as the morning meal and in the experimental sessions During the late afternoon the dogs were also given a mixture of evaporated milk, water, Pablum, and a little meal and horse meat. Water, in a large bucket, was kept in the cage at all times.

3. *Housing*

The Chow-Basenji puppies were kept in a large, well-ventilated cage in a converted poultry house, which was used as a main wing of the dog quarters The cage floor measured approximately 6⅓ feet by 12⅓ feet. The ceiling curved from a maximum height of approximately 10 feet to the floor. The base of the floor was of cement, and was covered with wood shavings Similar cages housing other dogs were adjacent to and across from the cage in which the experimental animals were kept.

The Terrier-Dachshund puppies were housed in a large, well-ventilated cage in the nursery wing of the laboratory. The cage floor was approximately 9⅔ feet by 17½ feet, and was covered with wood shavings Some large platforms, den, and runway were also present in the cage Each cage was cleaned (feces removed, some clean sawdust put in, water bucket filled, etc.) every morning before the feeding session Regular sterilization of the cages, in keeping with the laboratory routine, was done

4 *Solitary and Group Feeding*

The basic procedure is concerned with the determination of the exact amounts ingested by each of the dogs under the conditions of solitary and group feeding. A large pan, approximately 7 x 11 x 1½ inches was used in all of the feedings for the Chow-Basenji, and a pan 8 x 5½ x 2 for the Terrier-Dachshund puppies It was found that these dishes were large enough to provide comfortable access by each member of the litter even in the group situation. No barking, growling, or fighting was evident when the dish was used The animals were fed in every case in their home cage

In the group feeding, each dog was weighed immediately before the feeding in an outer room This weighting, and all other weightings reported here, were made on a Fairbanks scale of 35-pound maximum capacity, graduated in 0 25 ounce units Estimates were made to the nearest tenth of one ounce The food was also weighted on the scale When all the subjects had been weighted, the food weight determined, and the dogs returned to the home cage, then the animals were fed in the home cage for a fixed period. This period was 90 seconds for the Chow-Basenji subjects, and 120 seconds for the Terrier-Dachshund puppies Any significant behavior during the feeding period was noted by the experimenters, who were observing from a sheltered corner of the adjacent alley. As soon as the feeding period was ended, the animals were taken out singly and reweighted The food was also reweighted. Thus, for the session the data included. food weight before feeding, individual weight before feeding, food weight after feeding, and individual weight after feeding. From these data, the total amount of food eaten by the dogs, and the increase in weight of each dog after the feeding were determined A basic order was used in the handling and weighting procedure as indicated in Table 3 In the order above Day 1 was concerned with group feeding, and Day 2 with solitary feeding This alternation was continued until all of the data had been gathered

In the solitary feeding, each dog was weighed immediately before and after feeding as above However, in this case all of the dogs had been removed to a holding cage in another part of the laboratory. After the food had been weighed, the dog was permitted to eat in his home cage out of the same dish described above for the proscribed period After feeding, the dog

TABLE 3

Day 1	494, 495, 496, 497
Day 2	495, 496, 497, 494
Day 3	496, 497, 494, 495
Day 4	497, 494, 495, 496, etc
Day 1	505, 506, 507, 510, 511, 512
Day 2	506, 507, 510, 511, 512, 505
Day 3	507, 510, 511, 512, 505, 506
Day 4	510, 511, 512, 505, 506, 507
Day 5	511, 512, 505, 506, 507, 510
Day 6	512, 505, 506, 507, 510, 511, etc

and the food were weighed, and the amount consumed and the increase in weight of the dog were determined. The next dog was brought in, and the same procedure continued. The order of handling and weighing were the same as used the previous day in the group situation. From the data of this section, the increase of weight in each dog, the amount of food eaten by each dog, and the total amount of food taken by the four subjects were determined.

The experimental feeding situation (group or solitary) described above took place between 9 and 10 A.M. each day In the afternoon, between 3:30 and 4 P.M., a supplementary feeding was given to all of the animals in a group, but no data were taken at this time.

C. Results and Discussion

The basic data are shown in Table 4 This table includes date, condition, body weight change of each animal for each feeding, the total body weight change for the group, the food weight change for each subject for the solitary feeding, and the total food weight changes for each condition. The data cover a total of 24 days for the Chow-Basenji subjects: 12 days for the solitary condition and 12 days for the group feeding condition; and 20 days for the Terrier-Dachshund subjects: 10 days of solitary feeding and 10 days of group feeding.

The analysis of the data shown in Table 4 will be concerned with three points First, for the group: was there a difference in the amount eaten (as measured by food weight change) under the two conditions? Second, what is the relationship between the measures of food intake, body weight change, and food weight change? Third, what was the effect of group and solitary feeding on each subject?

1. *Group Results*

Using only the results secured by measuring the change in food weight (shown in Table 4), it was found that for the Chow-Basenji subjects for the period of group feeding (12 days), a total amount of 630.9 ounces was eaten. For the comparable solitary feeding period, a total of 551.9 ounces was eaten. The daily means are 52.58 for the group feeding and 46.0 for the solitary feeding.

For the Terrier-Dachshund puppies for the period of group feeding (10 days) a total of 131.9 ounces was eaten. For the comparable solitary feeding period, a total of 71.0 ounces was eaten. The daily means are 87.5 for the group situation and 58.1 for the solitary situation.

One method of expressing these results is to use a ratio of total amount eaten in the group feeding divided by the total amount eaten in the individual feeding. If such a ratio is computed for each group of subjects, it is found to be 1.14 for the Chow-Basenji puppies, and 1.51 for the Terrier-Dachshund puppies. These ratios represent a difference of 14 per cent and 51 per cent more food eaten in the group situation over the experimental period.

The distributions of amount eaten under the two conditions were further compared using the chi-square technique. The suggestion by Weil (12) for the evaluation of growth curve data seemed applicable here. The solitary feeding data were taken as the expected results and were compared to the group feeding data on a day-to-day basis. The chi-square values were found to represent significant differences at the .01 level.

Harlow's findings (4) are of pertinence in this discussion. He reported significant differences in the amount eaten in solitary and group feeding by two equated groups of rats. The present findings support the interpretation of social facilitation of feeding in terms of the amount eaten *by the group* of subjects under solitary and group conditions. The increase in food consumed by the two groups of subjects is in the order of 14 and 50 per cent.

2. *Food and Body Weight Measures*

The basic problem to be discussed in the next section, namely, the effect of the feeding situation on the individual performance, will depend in part on the usefulness of the body weight data. It will be recalled that in the group feeding situation, in addition to the food weighing, each subject was weighed *before* and *after* each feeding. The change in body weight, however, was the only datum for the individual in the group feeding situation. Of course, the body weight changes for all of the subjects should approximate the *total food weight* change. This problem does not exist in the individual feeding situation, since each subject was weighed before and after feeding, and the food weight change could be compared directly.

In spite of errors introduced by the spilling of food, by occasional urination before weighing, and by defecation in a few instances, approximately the same results obtain from a consideration of the body weight change. The ratio for group feeding to individual feeding for the Chow-Basenji puppies, as determined from total body weight was 1.16, as compared to 1.14 determined from total food weight change. The comparable ratios for the Terrier-Dachshund subjects were 1.50 for the body weight change as compared to 1.51 for the food weight change.

A product-moment correlation coefficient was calculated for each group of subjects, in which the individual food weight and body weight change measures (from the solitary feeding data) were used. The coefficients were 0.97 for the Chow-Basenji group, and 0.99 for the Terrier-Dachshund group. It will be seen that a close degree of relationship exists between the two measures. It is necessary to establish this relationship before the individual results can be considered.

3. *Individual Results*

The major aspects of the study should be found in a consideration of the effect of the experimental conditions on the individual subjects. It has been demonstrated in the previous section that as a group, the subjects ate more in the group feeding than in the individual feeding.

Using only the body weight results for the analysis, the mean amounts per feeding in ounces for each of the conditions, together with the ratios, are found in Table 5.

TABLE 5

	Subject	Group Feeding	Solitary Feeding	Ratio
Chow-Basenji	494	10.7	10.4	1.03
	495	16.3	13.4	1.22
	496	12.0	9.7	1.24
	497	13.0	11.3	1.15
Terrier-Dachshund	505	13.2	7.0	1.86
	506	15.1	9.8	1.54
	507	10.2	7.2	1.42
	510	16.7	12.6	1.33
	511	17.2	12.0	1.43
	512	13.3	9.5	1.40

From these results it can be seen that the ratios in every case are greater than 1 00. The ratios range from 1 03 to 1 86 These ratios represent an increase of from 3 per cent to 86 per cent in the amount eaten by each subject under the condition of group feeding.

Thus, it can be stated that there are wide differences in the effect of the group on the individual feeding performance. However, the trend for facilitation holds in every case, and inhibition of eating due to the presence of other animals is not clearly apparent

It is not difficult to conceive of inhibition due to social stimulation. The results of this experiment must, therefore, be interpreted in terms of the subjects and the experimental conditions. Several variables seem to be of importance for further investigation in this connection Some of these might be

a. Breed and species. It may be that different results might be obtained if other breeds were used, and that the findings are dependent on the particular cross studied.

b. Age The possibility of age as a variable has been raised by Harlow It may be that the facilitation reported here exists only during the early stages of development, and with the appearance of maturity and sexual development, such facilitation might not be obtained.

c Competition It has been suggested that competition is the essential factor. An attempt was made to measure food dominance relationships among the subjects, but no reliable relationships could be determined. It could be that with the *development* of fixed dominance relationships other effects of the group would be found

d. Previous history The previous experience of the subject would seem to be a major variable The present subjects had been raised as a litter, had nursed together, and when weaned had lived together Thus, it may be that what is reported in this experiment is really an *inhibition* of feeding in the solitary situation, due to previous group life of the subjects. Some effects of solitary living have been reported recently by Riess (11) for the rat

e Conditions of feeding Another major variable of the experimental arrangements are the details of the feeding situation In the present experiment, the conditions were such that a *large* amount of food was presented in a *large* dish If a scarcity of food existed or if the food dish were small, possibly other results would have been obtained

f Size of group Although Harlow's findings (4) do not seem to indicate an effect due the varying size of the group (3, 4, or 5 members), this is a variable to be manipulated further

D. Summary

The effect of feeding with the litter and in the solitary state was determined by the measurement of food eaten and body weight change in a group of four Chow-Basenji puppies and six Terrier-Dachshund puppies.

In the group feeding situation, the first group of subjects ate approximately 14 per cent more than in the solitary state The second group of subjects ate approximately 51 per cent more Individual performance for the two conditions of feeding varied from 3 per cent to 86 per cent increase in the food eaten in the group situation as compared to individual feeding.

Several significant variables in regard to the phenomenon were indicated and discussed.

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STUDIES IN DELINQUENCY: I. PERSONALITY STRUCTURE OF DELINQUENT BOYS*[1]

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A. PROBLEM

Of the two major approaches to personality, the holoistic in which personality is an essential indivisible unity (an *in sich geschlosene Ganzheit*) destroyed on analysis, and the atomistic in which personality has been defined as a sum of all the traits, abilities, interests, and characteristics of the individual (7, p. 24), the latter concept is more susceptible to analysis and quantification, and of the two analogous approaches to the study of personality, the projective and nomothetic methods, the latter does not yield results which experimenters see "only through the refracting lenses of their own personalities" (1, p. 286), but this last need not be construed as a complete rejection of projective principles. The nomothetic approach seemed the most promising approach to the problem of delinquency in boys. The study of this atypical behavior must have its focus in the personality of the delinquent and in those factors of heredity and environment which are reflected in the personality of the individual. Differentia in personality structure, in which traits form the facets expressed in quantitative terms, of delinquents and non-delinquents may be revealed in an intensive study of a comparatively small group. The immediate problem resolves itself into a triad. (*a*) What is the personality structure of delinquent boys? (*b*) What is the personality structure of non-delinquent boys? (*c*) From differences, can a method be found for the prediction of delinquency in boys?

B. METHOD

Fifty boys in an industrial school and 50 boys in a public school served as subjects, equated for age and national origin. The mean age for the industrial school boys was 15.5±0.755 years; the mean age for the public school boys was 15.5±0.494 years. This age group was selected for two reasons: more tests are available which would fit this age group so enabling

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a greater number of personality aspects to be measured, again, delinquency in boys is likely to reach its peak frequency at about this time (3, 4). The group selected would present an exacerbation of the delinquency syndrome, making differentiation easier; in younger boys the same traits may be presented, but to so much milder a degree that the characteristics of delinquent boys would be more difficult to uncover Equating for national origin was approximate If the boy spoke Spanish, it was assumed that he had learned it at home from parents of Mexican national origin and could be matched with a boy of similar national background. All of the boys were white Five boys from each group had names of non-Latin origin, but spoke Spanish at home.

It was not possible to retain the original group with which the study began throughout the testing period. Some of the boys in the industrial school dropped out of the group for various reasons such as release from the school or inability to read, and had to be replaced. The newcomer then began the tests with the first and continued through the series. One or two of the scores in the control group could not be used since the boys were reported problem or delinquent children. The number 100 represents a residuum, it consists of boys who began the tests, were able to finish them and, in the control groups, were considered suitable subjects, i.e., were not reported by the school as serious behavior problems or delinquents.

The following standardized tests yielded the data·

Revised Army Beta Examination
Adjustment Inventory (Bell)
Adolescent Adjustment Inventory (Cowan *et al*)
California Test of Personality, Intermediate Series, Form *A* (Tiegs, Clark and Thorpe).
Personality Inventory (Flanagan scores)
Developmental Age Test (Furgey).
Personality Quotient Test (Link *et al.*)
MacQuarrie Test of Mechanical Ability
Mental Health Analysis, Intermediate Series, Form *A* (Thorpe, Clarke, Tiegs)
Otis Self-Administering Test of Mental Ability, Intermediate, Form *A*
Mechanical Aptitude Test (Stenquist).
Behavior Cards (Stogdill).
Stott's Inventory (Every-Day Life).
Personality Schedule (Thurstone).
Social Adjustment Inventory (Washburn)

These tests frequently have sub-tests yielding measures of traits, which were considered in the analysis of personality

Means, sigmas, and critical ratios provided the method of analysis (2, pp. 51, 201, 211, 213, 215) The criterion of a critical ratio of 3 00 or more was regarded as indicating a difference between the two groups not due to chance A check on the statistical results was super-imposed by clinical observation When both test results and clinical impression were congruent, the difference or similarity were accepted as valid; when clinical impression strongly failed to substantiate statistical findings, the statistical results were rejected since it is generally recognized that tests of personality in the present stage of development are not infallible measures, the results can be modified by the subjects, a consequence which may be particularly operative because of the nature of the study.

C. RESULTS

1 *Similarities*

Results are summarized in Table 1. The following tests did not differentiate between delinquents and non-delinquents

1 Stenquist Mechanical Aptitude Test
2. The B2-S (self sufficiency)
    B3-S (introversion-extroversion).
    B4-D (dominance-submission)
    F1-C (confidence in oneself)
    F2-C (sociability) scores of the Personality Inventory.
3. The total score of the Adjustment Inventory.
4 The Home Adjustment, Social Adjustment, and Emotional Adjustment scores of the Adjustment Inventory.
5. The Independence, Resourcefulness, and Personal Responsibility scores by Stott
6. The Personality Quotient Test
7 The happiness, sympathy, purpose, impulse-judgment, and self-control scores of the Social Adjustment Inventory

These results indicate that delinquents are not distinguished from non-delinquents in the following traits or aspects of personality. These similarities are indicated by critical ratios obtained, confirmed by other studies where these exist, and are congruent with clinical impression.

1 Dominance-submission
2 Confidence in oneself
3. Sociability.
4 Independence in personal matters.
5 Resourcefulness.
6 Habits of usefulness
7. Social initiative.

Trait	Test
Intelligence	Otis
Intelligence	Army
Mechanical ability	Sten
Mechanical ability	MacQ
Neurotic tendency	Bern
Self-sufficiency	Bern
Introversion-extroversion	Bern
Dominance-submission	Bern
Confidence in oneself	Flan
Sociability	*Flan*
Adjustment, general	Bell
Home adjustment	Bell
Health	Bell
Social	Bell
Emotional	Bell
Personal responsibility	Stott
Resourcefulness	Stott
Independence	Stott
Developmental age	Furf
Personality, general	Link
Social initiative	Link
Self-determination	Link
Economic "self-"	Link
Sex adjustment	Link
Adjustment, general	Wash
Happiness	Wash
Alienation	Wash
Sympathy	Wash
Purpose	Wash
Impulse-judgment	Wash
Control	Wash
Mental health, total	MHA

TABLE 1

OF DELINQUENT AND NON-DELINQUENT BOYS BASED ON SCORE MEANS, SIGMAS, AND CRITICAL RATIOS

r	M_1	SD_1	M_2	SD_2	CR	Concl.
948	82 6	12 6	92 7	10.1	4 43	
.987	85 5	10.6	95.9	8 84	5.34	
	40 4	15 4	43 9	10 8	1 28	
	36 3	11 4	54 7	17 7	5 98	
91	— 5 02	5 7	—67 8	59 7	7 41	
.92	6 56	28 1	4.12	36 8	373	
89	—30 9	38 4	—43 4	40 5	1.59	
89	21 7	40.2	31 2	43.6	1 13	
86	— 6 74	67 35	— 3 47	77 7	.225	
78	—42 2	72 0	—40 9	43.3	114	
93	42.9	15 9	37 2	16 8	1 74	
89	10 5	4 85	8 64	6 10	1 69	
.80	10 3	4 94	5 58	3 82	5 37	
89	13 3	6 03	15 2	5 04	1 71	
.85	10 0	6 30	8 48	5 51	1.31	Rejected
84	56 0	17 1	62 8	19 5	1 84	Rejected
90	48 8	11.0	55 6	16 4	2 45	
.94	55 9	13 9	59 4	14 8	1 22	
.91	87 3	10.6	97 1	8 14	5 14	
87	124.4	23 5	130 7	24 6	1 30	
82	62 0	16 1	59 3	14 4	877	
.88	50 5	11.2	56.4	12 5	2 49	
73	33 7	9 50	32 1	10 2	813	
78	24 8	9 13	23 7	7.76	625	
92	173 0	40 2	148 3	31 6	3 41	
80- 90	8 52	6 14	5 98	5 72	2 14	
"	32 1	17.4	20 1	13 5	3 84	
"	25 2	10.7	25 0	8 02	106	
"	61 3	13 2	55 0	12 0	2 49	
"	10 5	5 72	7.70	5 23	2 55	
"	16 3	8 62	13 6	9 32	1 52	
954	117 2	22 4	138 3	22 6	4 71	

Mental health, liabilities	MHA	924	48.7	16.5	65.6	13.1	5.69	
Behavioral immaturity	MHA		9.08	3.37	10.7	3.14	2.43	
Emotional instability	MHA		8.82	3.65	11.9	4.00	4.02	
Feelings of inadequacy	MHA		8.20	3.75	10.6	4.06	3.05	
Physical defects	MHA		12.3	4.56	17.0	3.37	5.87	
Nervous manifestations	MHA		11.4	4.76	16.3	2.88	6.23	
Mental health, assets	MHA	896	67.2	13.8	72.9	15.3	1.96	
Close personal responsibility	MHA		14.6	3.88	16.0	3.46	2.01	
Inter-personal skills	MHA		13.1	3.05	14.1	3.34	1.56	
Social participation	MHA		13.7	3.24	14.3	3.92	861	
Satisfying work and recreation	MHA		13.08	3.33	14.2	3.78	1.54	Rejected

LEGEND FOR TABLE 1

Army	Revised Army Beta Examination
Bell	The Adjustment Inventory by Bell
Bern	Personality Inventory by Bernreuter
C	Adolescent Adjustment Inventory by Cowan *et al*
Concl	Conclusion, whether the conclusion to which *CR* leads is accepted or rejected
CPI	California Test of Personality, Intermediate Series, Form *A*
CR	Critical ratio
Flan	Flanagan scales of the Personality Inventory
Furf	Developmental Age Test by Furfey
Keys	Personal Index Manual by Loofbourow and Keys
Link	Personality Quotient Test by Link *et al*
MacQ	MacQuarrie Test of Mechanical Ability.
M_1	Mean, delinquent group
M_2	Mean, non-delinquent group
MHA	Mental Health Analysis, Intermediate Series, Form *A* by Thorpe, Clark, and Tiegs
Otis	Otis Self-Administering Test of Mental Ability, Intermediate Form *A*
r	Reliability of test used to measure the trait.
SD_1	Standard deviation, delinquent group
SD_2	Standard deviation, non-delinquent group
Sten	Mechanical Ability Test by Stenquist
Stog	Behavior Cards by Stogdill
Stott	Stott's Inventory, Every-Day Life
T	Truth or rapport score.
Thur	Personality Schedule by Thurstone
Wash	Social Adjustment Inventory by Washburn

8. Self-determination
9. Economic self-determination.
10. Adjustment to opposite sex
11. Happiness
12. *Sympathy*
13. Impulse-judgment
14. Self-control.
15. Behavioral immaturities
16. Mental health assets
17. Interpersonal skills
18. Outlook and goals
19. Self-reliance
20. Sense of personal worth
21. Sense of personal freedom.
22. Feeling of belonging
23. Social skills.

Test results indicate that in the following traits delinquent boys do not differ from non-delinquent, but this is so strongly contradicted by clinical impression that the test results are rejected as not representative:

1. *Personal responsibility.*
2. Emotional adjustment.
3. Satisfying work and recreation
4. Family relations
5. Community relation.
6. Neurotic tendency.

It may be noted that the validity of the results is undermined by the inequalities of reliabilities in the scores The reliabilities of the scores are indicated in Table 1.

The preceding analysis shows how the delinquent is in many ways similar to the non-delinquent It is the presence of these traits which suggests that the change to non-delinquent behavior is possible and not prohibitively difficult. However, society sharply differentiates the two groups and the differences between them are important.

2 *Differences*

The following tests differentiate between delinquent and non-delinquent groups (Table 2).

1. Otis Self-Administering Tests of Mental Ability, intermediate, Form *A*.
2. Revised Army Beta Examination
3. MacQuarie Test of Mechanical Ability

TABLE 2

COMPARATIVE PERSONALITY STRUCTURE OF DELINQUENT AND NON-DELINQUENT BOYS
SIGNIFICANT DIFFERENCES BASED ON MEANS, SIGMAS, AND CRITICAL RATIO OF SCORES

Trait	Test	r	M_1	SD_1	M_2	SD_2	CR
Intelligence, verbal	Otis	948	82.6	12.6	92.7	10.1	4.43
Intelligence, non-verbal	Army	.987	85.5	10.6	95.9	8.84	5.34
Mechanical ability	MacQ		36.3	11.4	54.7	17.7	5.98
Neurotic tendency	Bern		— 5.02	5.7	—67.8	59.7	7.41
Health adjustment	Bell	.93	10.3	4.94	5.58	3.82	5.37
Developing age	Furf	91	87.3	10.6	97.1	8.14	5.14
Adjustment	Wash	92	173.0	40.2	148.3	31.6	3.41
Alienation	Wash	80-90	32.1	17.4	20.1	13.5	3.84
Mental health	MHA	954	117.2	22.4	138.3	22.6	4.71
Mental health, liabilities	MHA	924	48.7	16.5	65.6	13.1	5.69
Emotional instability	MHA		8.82	3.65	11.9	4.00	4.02
Feelings of inadequacy	MHA		8.20	3.75	10.6	4.06	3.05
Physical defects	MHA		12.3	4.56	17.0	3.37	5.87
Nervous manifestations	MHA		11.4	4.76	16.3	2.88	6.23
Adjustment, total	CPI	.932	114.5	23.9	136.0	23.4	4.54
Self-adjustment	CPI	898	55.9	14.4	68.4	13.7	4.43
Withdrawing tendencies	CPI		7.52	3.76	10.7	3.28	4.45
Nervous symptoms	CPI		8.92	3.50	11.8	2.79	4.54
Social adjustment	CPI	873	58.8	13.0	67.8	11.7	3.63
School relations	CPI		9.38	2.90	11.2	2.68	3.22
Anti-social tendencies	CPI		8.12	3.10	10.0	3.19	2.98
Problem attitudes	Keys	90	43.0	18.4	32.6	14.1	3.17
Problem behavior	Stog	92	57.7	20.4	35.2	17.6	5.82

For legend see legend for Table 1

4 BI-N (Neurotic Tendency) score of the Personality Inventory

5 Health Adjustment score of the Adjustment Inventory (Bell)

6 Furfey Test of Developmental Age

7 Social Adjustment and alienation scores of the Washburn Social Adjustment Inventory

8 Mental Health Analysis

9 Mental Health Liabilities, Emotional Stability, Feelings of inadequacy, and Nervous manifestations scores of the Mental Health Analysis

10 *California Test of Personality*

11 Withdrawing tendencies, nervous symptoms, social adjustment, and school relations scores of the California Test of Personality

12. Personal Index.

13 Behavior cards

In the following traits delinquents differ from non-delinquents:

1. Intelligence, verbal and non-verbal.
2. Mechanical (possibly clerical) ability.
3. Neurotic tendency
4. Health adjustment.
5. Developmental age
6. Mental health
7. Mental health liabilities
8. Emotional stability
9. Feelings of inadequacy
10. *Reported physical defects*
11. Nervous manifestations
12. General social adjustment
13. Self-adjustment
14. Withdrawing tendencies.
15. Nervous symptoms.
16. School relations.
17. Anti-social tendencies.
18. Problem behavior.
19. Problem attitudes
20. Emotional adjustment
21. Satisfying work and recreation
22. Family relations
23. Community relations

D. CONCLUSIONS

The delinquent boy is less intelligent, has less of a certain type of mechanical or clinical ability, his health adjustment is less good, he is less social, less well socially adjusted, his school abilities are poorer, his family relations are less good, and his community relations are poorer. The delinquent boy presents a psychological deficit. His is a less adequate personality.

Delinquency can probably be predicted from lower scores with some success after the method described by Springbett (6) The pre-delinquent boy is confronted with a series of failures or inadequacies which finally suppurate into the full-fledged clinical syndrome. Clinical delinquency however, becomes more than a series of inadequacies or failures, it is a positive adaptation to unresolved and apparently unsolvable problem. The delinquent boy has found an answer; he has found a mode of reaction which solves his problem, at least temporarily, a behavior pattern which becomes indurated with time. Shields (5) has drawn a similar conclusion for criminals, that the criminal is an inadequate personality unable to meet the problem of social, economic, emotional, and love security. The criminal is more than this, he is an inadequate personality which discovers criminality or delinquency as a mode of reaction which solves some of his problems, in a manner which grows into a stable habit-system

The major difference between delinquents and non-delinquents seems initial psychological inadequacy plus the development of a new, socially unacceptable, adjustive reaction which society designates as delinquency.

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STUDIES IN DELINQUENCY. II. PREDICTION OF DELINQUENCY IN BOYS*[1]

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Case studies, which give a sense of concreteness to psychological research and are a welcome qualitative contribution to the problem, have not been included in this study since excellent studies of delinquent boys exist. Quantitative studies in education have been criticized as "statistical froth" (3, p. 18) Qualitative discoveries can be of great value and research need not be conducted as if there were no truth but statistical truth. Nevertheless, Sarbin (6) has been able to show that clinical material adds nothing in efficiency to statistical methods of prediction when case study material is compared to actuarial methods

Lawshe and Thornton (5) have made use of the regression equation for prediction with marked success However, it did not seem advisable to apply the method to the prediction of delinquency in boys There is a heavy affective concomitant found in working with maladjusted boys Extensive and repeated testing does not influence the situation favorably. It often represents an assault on the personal integrity of the individual particularly in the delinquency, and easily leads to various degrees of negativism Tests themselves are not without an irritating influence The entire situation is apt to produce an unreliability in the results and in a field where the variability of data is the despair of investigators. Again, when the variability of the data is considered and the small decrease which the sigma of estimate represents over the sigma of measurement, the determination of regression equation weights seems an unprofitable task Lastly, the regression equation method is cumbersome to use, a fact which would militate against the use of the results in schools where the prediction of delinquency could be made with greatest fruitfulness For these reasons, a single instrument which would reduce overlapping to a minimum and add precision to prediction may answer the need better than a regression equation based on multiple variables. An attempt was made to construct such an instrument

From the tests used, 1,385 items more analyzed by means of Zubin's

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nomographs from which were derived probabilities that items truly differentiate *the two groups (7). P was read directly from the Zubin's nomograph* (Chart III) and the level $P = 01$ was chosen as showing true differences between the two groups. From the 1,385 items analyzed, 240 met this level of significance. The equivalent values of P in units of normal distribution were used as a basis for unitary weights, as shown in Table 1.

TABLE 1
BASIS FOR THE WEIGHTING OF ITEMS (4)

P	X	*Difference*	*Weight*
01	2 3263		1
.005	2 5758	2495	2
.001	3 0902	5144	3
.0005	3 2905	2003	4
10^{-4}	3 7190	4285	5
10^{-5}	4 2649	5458	6
10^{-6}	4 7534	4886	7
10^{-7}	5.1993	4459	8
10^{-8}	5 6120	4127	9
10^{-9}	5.9978	.3858	10

When the items were weighted, each odd item was matched with an item of equal weight. The method of logically equivalent rather than *random-split halves seemed defensible for the calculation of odd-even reliability.* Random splitting would yield a smaller reliability but not a truer one (2). The half composed of odd items was theoretically equal to the half formed by the even items; the two halves of the test appeared equivalent. This matching of item for item by weight further reduced the number from 240 to 228 since some items could not be matched.

Because of the nature of the test, a truth score was introduced. This consists of 52 items, the response to which is known with some certainty An example of such an item is, "Do your muscles ever shiver or shake when you get cold?" The expected response to this query is rather certain. The responses to some items (as, "Did you ever cry at a movie?") are less certain, and a rather liberal *criterion of 26 for the truth score was permitted* This score is derived from 52 items placed at regular intervals throughout the test, and again a weight of one toward a truth score was assigned when answered as expected Possibly the term "rapport scores" would be a better choice, it is a measure of the extent to which the boy is willing to reveal himself or seeks to hide himself. This score, however, is used only as an indication of rapport and does not enter into the delinquency score where its uncertain values would muddy the results.

The assembled test was administered to about 300 delinquent boys in

Arizona and California State industrial schools These boys come from all parts of Arizona and California, and the California group may be regarded as a particularly fine sample. The test was given to an equivalent number of boys in a public junior high school in Tucson, Arizona. The age range in both groups was 12-17, the range in which the test would be most useful.

Odd-even reliability of rationally equivalent halves of the test was determined to be 0 834± 007 corrected to .910±.007 The mean for the delinquents was found to be 327 0, a standard error of 90 5, with $N = 265$ Statistical determinations for the non-delinquent group were· $M = 126.2$, $SD = 58.1$, $N = 265$.

The items themselves give some assurance of validity since they were incorporated into the test because they distinguish the two groups according to a given criterion The validity of the test as a whole is its ability to distinguish a dichotomy. The extent to which the test scores were determined from bi-serial *r*, found to be 0 998± 008. The tests results yielded a critical ratio of 29.2 These statistical techniques are strong indications that test validity is item validity.

Again, in the public school group, tests of known delinquent and problem children, as reported by the principal's office, were eliminated from the non-delinquent group. Some of the scores in the non-delinquent group were retained although they were made by proto-delinquents, boys who have committed punishable acts, but were never in open conflict with school or court This was done to keep the differences at a conservative level. It also seemed best to retain these scores since children who never commit a punishable delinquent act must be rare, and certainly not truly representative of the group. The scores were included since the boys were not overtly maladjusted, and their covert behavior could not be determined more certainly

The mean for non-delinquent boys, 126.2, and the mean for delinquent boys, 327.0, may be considered psychological Plimsoll marks The first Plimsoll represents the line or point above which the individual may not be loaded with delinquent traits without exposing the boy to the danger of falling into delinquency. The greater the rise of the score above this mark, the greater the chances of becoming delinquent

The second Plimsoll mark, 327 0, is the mark above which the boy will certainly come into open conflict with authorities, no boy making a score above this point was in the non-delinquent group. Scores falling below the mean for non-delinquents are considered non-delinquent scores. No delinquent, proto-delinquent, or problem boys were found below 126 2 Scores falling above the mean for delinquent boys are delinquent scores. All boys

Score	Percentile Delin.	Percentile Non-delin.	Per cent of Delin	Per cent of Non-delin.	Comment
575-599.9	100.0*		100		
550-574.9	99.6		100		
525-549.9	99.2		100		
500-524.9	98.1		100		
475-499.9	96.2		100		Clinical delinquents
450-474.9	93.2		100		
425-449.9	90.2		100		
400-424.9	86.4		100		
375-399.9	79.2		100		
350-374.9	72.1		100		
325-249.9	61.1		100		
Second Plimsoll mark					
300-324.9	50.2	100.0*	95	5	
275-299.9	36.6	99.2	83	17	Potential delin
250-274.9	29.4	97.2	77	23	*former delin.*
225-249.9	23.0	95.8	72	28	proto-delin
200-224.9	15.1	92.8	55	45	prope-delin.
175-199.9	7.2	86.4	42	58	problem boys
150-174.9	3.0	80.8	13	87	
125-149.9	1.5	70.9	11	89	
First Plimsoll mark					
100-124.9		58.5		100	
75- 99.9		40.0		100	Non-delin.
50- 74.9		18.9		100	
25- 49.9		4.2		100	

Note:

	Delinquent	Non-delinquent
Number	265	265
Standard deviation	90.5	58.1
Mean	327.0	126.0

Critical ratio = 29.2

r = .834 PE = .007

r_{corr} = .910 $PE_{r_{corr}}$ = ± .007

r_{bis} = .998 $PE_{r_{bis}}$ = ±.008

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*Upper limits of step; these are theoretically impossible values and should not be used.

scoring above this point were delinquent boys Scores falling between these two means are more difficult to interpret. They seem to consist of *scores of four groups* *former delinquents, proto-delinquents, prope-delinquents*, and problem boys. These are potentially delinquent boys. Former delinquents are boys who have been in open conflict and were brought into court Proto-delinquents are boys who engaged in punishable delinquencies but have not been in court. Prope-delinquents are boys who make high scores within the potentially delinquent range, they have many of the traits

TABLE 2
THE PREDICTION OF DELINQUENCY

of delinquent boys but have not engaged overtly in punishable delinquent behavior Delinquency would be very easy for them; it seems only a step away. Frequently prope-delinquents are neglected children The last group is made up of problem boys. These have not yet been brought into court but are already in open conflict. Bodin (1) reports that 92.5 per cent of the problem children in his study had become delinquent or criminal by the time the boys reached 21 and the girls 18 years of age.

None of these classifications is exclusive. Table 2 will assist in the interpretation of raw test scores and the prediction of delinquency.

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AN EXPERIMENT IN PURSUIT OF "COLOR-BLINDNESS"*

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An exploratory study by two of the writers (7), utilizing the Dvorine (4) Color Perception Testing Charts, showed a developmental trend in the color naming and discrimination responses to colored digits investigated in a group of 74 *S*'s ranging from three to eight years of age.

It was also found that none of the three-year-olds was able to name the standard hues or gray properly. For example, red was called brown, blue, and pink, while blue was misnamed red, purple, green, and black. Subsequent age groups showed a gradual increase in effectiveness of color naming. No sex differences were found.

As regards either naming or tracing the Dvorine digits, none of our three-year-olds could rise to the occasion. Following age groups, however, showed an increase to 77 per cent responses at the eight-year level. Again sex differences were found to vary more within the sex groups than between them. Preschool *S*'s were sharply distinguished from school groups in both performances.

In terms of conventional color perception theory, which sharply separates sex groups on an alleged hereditary basis, such results as we obtained were provocative enough to warrant a more elaborate investigation particularly around the school entering ages inasmuch as the "threshold" for the acquisition of color discriminations of the type demanded by the Dvorine charts seemed to be indicated at around this point. It was also hoped that data might be uncovered pertaining to the problem of the alleged differential "color-blindness" of the sexes. The end result was the present study.

A. Experimental Method

1. *Materials*

The Dvorine (4) Color Perception Testing Charts were selected for this study primarily because this is a rather new test and because it appears

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to be more complex or sensitive, at least as judged by the greater number of charts (60) and greater combinations of hues and digits in comparison with other standard tests.

2. *Subjects*

In order to avoid selection of subjects we arranged to include the entire population of the kindergarten, first, second, and third grades of the Fairmount school. In addition to a full coverage of the range of individual differences, we also obtained a rather homogeneous socio-economic group by restricting ourselves to this sample. Our total group, thus, included 245 *S*'s, 119 males and 126 females These were distributed by grades in the following manner: 19 males and 25 females in the kindergarten, 31 males and 34 females in the first grade, 34 males and 32 females in the second grade, and 35 males and 35 females in the third grade.

3 *Procedure*

Each *S* was administered the Dvorine charts individually in a room permitting daylight illumination of the test materials placed about 16 inches from the eyes. A number recognition test was used to determine whether or not *S* would be asked to name or trace the digits appearing on the plates. In the kindergarten and first grade, many of our *S*'s had to be required to trace the numbers appearing in the charts However, the data employed here compare our *S*'s on the basis of their number recognition throughout the test as well as on their performance in the color nomenclature portion of the test. This latter requires the child to name hues and tints of eight basic colors of the rotating disk, a circular opening permitting the exposure of one color at a time so as to prevent color recognition by contrasting it with another seen at the same time.

After the color nomenclature test was completed, each *S* was shown the first chart in the book, the number was indicated to him and then he was asked to report the number or numbers appearing in the subsequent plates, exposed to him one at a time. Passes and failures were quickly recorded by checking in the appropriate column on the record sheets. In the event of a "wrong" response (i e., a number other than the one on the chart), this response was also recorded.

It should be pointed out that rapport was easily established with our *S*'s, this was indicated by their eager participation in an activity that came as a welcome distraction from the daily classroom routine.

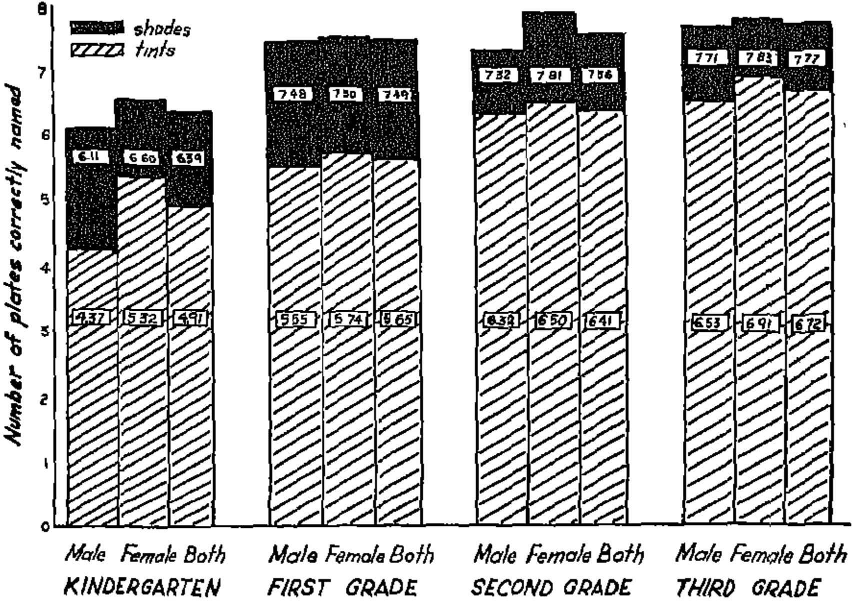Number of plates correctly named
0
1
2
3
4
5
6
7
8
shades
tints
6.11
6 60
6.39
4.37
5 32
4.91
7 48
7 50
7 49
5 65
5 74
5 65
7 32
7 81
7 56
6 32
6 50
6 41
7 71
7 83
7 77
6 53
6 91
6 72
Male Female Both
KINDERGARTEN
Male Female Both
FIRST GRADE
Male Female Both
SECOND GRADE
Male Female Both
THIRD GRADE

FIGURE 1

B. RESULTS AND DISCUSSION

1. *Color Nomenclature*

Sex groups by grade shown in Figure 1 give the over-all picture. The first obvious result is the developmental trend indicated by the bar diagram. Note that results for naming shades show a marked difference between the kindergarten *S*'s on the one hand and all the other groups on the other. Apparently, these are relatively easy discriminations that become stabilized at about the first grade level. However, the results for naming tints show a more continuous development throughout the grades as indicated by the gradually increasing means of 4.91, 5.65, 6.41, and 6.72 for kindergarten, first, second, and third grade respectively. Compare with results for shades which give the following comparable figures: kindergarten, 6.39; first grade, 7.49, second grade, 7.56 and third grade, 7.77.

As to sex differences, computation of tests of significance shows that statistically and behaviorally our males and females are not distinguishable groups

MEAN CORRECT NAMING RESPONSE BY GRADE AND SEX
FOR EIGHT DVORINE SHADES AND TINTS

The *CR* for kindergarten males vs. females is .83 for shades and 1.57 for tints, while *CR*'s for the other grades are still lower. Even visual inspection shows sex differences to be either insignificant or non-existent for both shade and tint responses in the other grade levels.

A more specific analysis of nomenclature data is shown in Table 1 where percentages of color naming responses for sex and age groups are shown for each of the tints and shades. An over-all remark about these results should first call attention to the fact that none of the *CR*'s here is statistically significant since none is over 2.88.

Furthermore, out of the 64 possibilities for significant sex differences, in only seven instances are the *CR*'s over two but under 2.88. In fact, in one case males are superior while in six instances females are slightly superior but, more important, all these seven cases occur in the tint category of naming responses. It will be noted that all the *CR*'s in the shade responses are under two and that at the third grade level sex differences reach almost a vanishing point.

It is interesting to compare the *CR* of .28 for the male vs. female differences in the violet *shade* response with the *CR* that approximates a 3.0 level of significance for the sex differences in the violet *tint* class of naming re-responses. There is a suggestion here that males and females name standard colors similarly but are from earliest times differentially educated with respect to *tints of the same hues*.

It should also be pointed out that although the sex differences for violet tint responses yield a *CR* approximating 3.0, nevertheless the differences for the blue and red shade and tint naming responses yield low *CR*'s indicating lack of sex differences. Since in terms of traditional color theory, red and blue are components of the violet color, this discrepancy of results offers some embarrassment to that theory.

Furthermore, if one overlooks the lack of significance in sex differences for all our groups in the violet shade responses and restricts attention to the violet *tint* portion of Table 1, there is an apparent decrease in the sex differences as indicated by the lower *CR*'s for first, second, and third grade boys and girls. While these differences are not consistent, nevertheless, they show a trend which may be interpreted as a reflection of a generally increasing familiarity and resultant discriminability of the violet tint with age increase. Certainly, our data could not be easily reconciled with any theory that speaks in terms of an alleged inherent defectiveness for "perceiving violet." Mere inspection of the reversal of the male-female percentages for violet as

TABLE 1

PERCENTAGE OF *S*'S CORRECTLY NAMING EACH OF THE EIGHT DVORINE SHADES AND TINTS AND *CR*s FOR SEX DIFFERENCES BY GRADE GROUP

	Kindergarten			First			Second			Third		
Shade	% Male	% Female	*CR*	% Male	% Female	*CR*	% Male	% Female	*CR*	% Male	% Female	*CR*
R	89.5	100.0	47	96.8	100.0	1.07	91.2	100.0	1.80	100.0	97.1	1.02
G	94.7	84.0	1.20	100.0	100.0	—	100.0	100.0	—	100.0	100.0	—
B	78.9	92.0	.67	96.8	100.0	1.07	97.0	100.0	1.06	97.0	97.1	02
Y	68.4	84.0	1.48	87.1	97.0	1.49	97.0	96.9	02	97.0	100.0	1.07
Bn	89.5	92.0	09	100.0	97.0	1.06	94.1	100.0	1.48	100.0	100.0	—
O	84.2	92.0	29	100.0	91.2	1.80	100.0	100.0	—	100.0	100.0	—
V	57.9	72.0	28	93.5	94.1	10	85.3	96.9	1.71	100.0	100.0	—
Gy	47.4	44.0	.22	74.2	76.5	21	64.7	84.4	1.90	79.4	85.7	69
Tint												
R	63.2	76.0	92	64.5	76.5	1.06	85.3	96.9	1.71	79.4	97.1	2.37
G	89.5	88.0	06	100.0	100.0	—	97.0	100.0	1.06	100.0	100.0	—
B	63.2	88.0	1.94	93.5	97.0	66	91.2	100.0	1.80	97.0	100.0	.35
Y	73.7	96.0	2.06	100.0	97.0	1.06	97.0	96.9	02	100.0	100.0	—
Bn	36.8	40.0	22	29.0	58.8	2.55	47.0	50.0	24	73.5	57.1	1.46
O	47.4	56.0	57	58.1	44.1	1.14	64.7	65.6	08	61.8	71.4	.85
V	21.0	60.0	2.88	58.1	82.4	2.21	85.3	78.1	76	76.5	94.3	2.16
Gy	36.8	28.0	52	51.6	23.5	2.44	64.7	65.6	.08	64.7	71.4	60

SHOWING PERCENTAGE OF CORRECT NAMING RESPONSES
AS DERIVED FROM DATA IN TABLE II

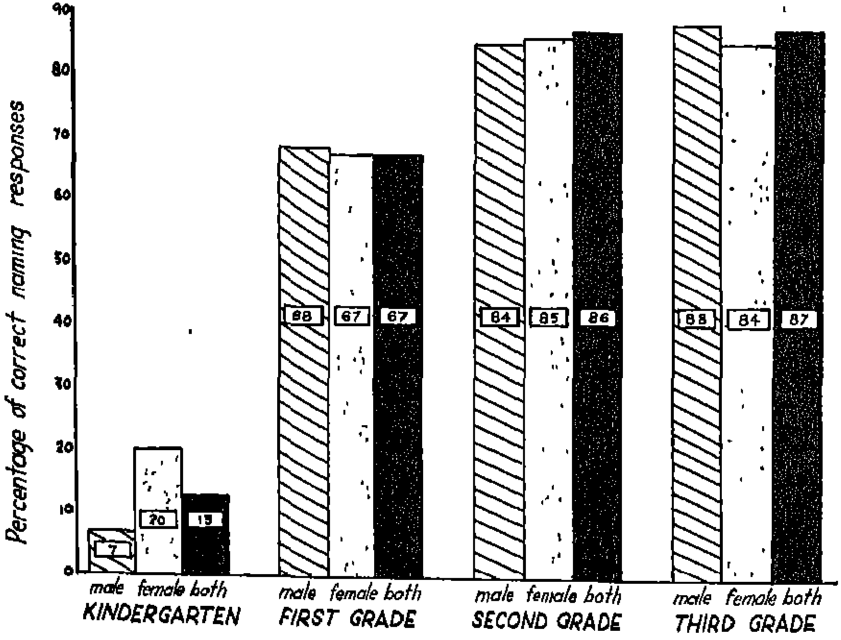

FIGURE 2

well as the other hues readily convinces one of the futility of such an interpretation

One last finding again points to the trial-and-error nature of the color naming responses of our younger *S*'s Protocols for the kindergarten group show a variety, but no consistency, in the names applied to the hues and gray. Violet is called orange and orange, pink. Blue is sometimes green and green, red, while yellow and orange are sometimes called black Gray is called both yellow and white Violet is often called blue but sometimes yellow, too; although yellow is also called violet. In other cases all the hues are named yellow and in still others white and purple indiscriminately. Thus, any hue may be called by the name of any other hue "Color-blindness" is indeed rampant in the kindergarten group.

2. *Color Perception*

Regarding results for Dvorine chart (number) naming responses, Figure 2 summarizes findings that are shown more specifically in Table 2.

The most apparent result concerns the discrepant percentage of correct naming responses as shown for our kindergarten group. There is a great gap between the earliest age group and the three others. The percentages of correct naming responses is 7 per cent for kindergarten males, 20 per cent for the females, while the overall percentage is 13 per cent Note that the first graders show an increase to 68 per cent for males, 67 per cent for females, and 67 per cent for both. The second and third graders apparently reach a plateau ranging only between 84 and 88 per cent

As far as sex differences are concerned the largest such difference occurs in our kindergarten group, but it is not statistically significant as indicated by the low *CR* of 1 31. In the other grades, sex differences are negligible However, since any possible sex differences in responding to individual charts might be obscured by this averaging process, it might be profitable to analyze the data by individual charts.

When this is done, we find that in 41 cases the discrepancy in the percentages of correct responses between males and females ranges only between zero and four per cent. In the case of 16 charts the sex differences range between five and nine per cent and for only two plates is the difference in the percentage of correct responses greater, namely between 10 and 14 per cent and in these two instances male responses are superior. However, even in the last instance these differences are not significant, for the *CR*'s derived here are 2.06 and 2.50. When we consider the relative performance of the sexes for all the charts, we find that in 35 cases males are superior, this is 59 per cent of the total possible Females are superior on only 15 plates or 25 per cent of the total possibilities. In nine charts or 16 per cent of the time the sex groups are equivalent

Another attack on the problem of sex differences is made possible by an analysis of the data involving Dvorine's Charts 2, 3, and 4 which are alleged to be visible to persons with normal color perception and are said to induce varied responses from those with defective color perception.

Although we have found no sex differences in the analysis of the responses of our total group, such differences could conceivably show up in the various grade groups, especially with respect to the three plates most diagnostic of color blindness. These are Plates 2, 3, and 4. Critical ratio tests of these sex differences do not approach statistical significance, the highest reaching a value of only 1 23.

Since, according to Dvorine, subjects with normal color perception pass Plates 2, 3, and 4, an analysis of our data in this respect seems to be called

TABLE 2

PERCENTAGE CORRECT RESPONSES OF 245 *S*'S BY GRADE AND SEX TO 59 DVORINE CHARTS

	Kindergarten			First Grade			Second Grade			Third Grade			Totals		
Chart	*M*	*F*	*M+F*	*M*	*F*	*M+F*	*M*	*F*	*M+F*	*M*	*F*	*M+F*	*M*	*F*	*M+F*
95	10	4	7	19	18	18	35	28	32	57	54	56	34	28	31
26	5	4	5	29	35	32	44	50	47	51	40	46	36	34	35
8	5	4	5	52	44	48	41	56	48	54	60	57	42	44	43
49	5	12	9	73	71	71	94	93	94	100	100	100	76	65	70
77	5	16	11	65	56	60	91	81	86	82	80	81	68	61	64
53	10	20	16	68	71	69	82	81	82	86	80	83	68	66	67
44	10	36	25	80	82	82	97	100	83	100	97	99	80	82	81
87	10	16	11	48	44	46	76	87	82	86	86	86	61	53	57
20	5	24	16	77	79	78	88	84	86	91	77	84	73	69	71
67	5	8	7	71	79	75	97	100	83	97	94	96	76	75	75
35	5	24	16	68	67	68	58	65	62	89	74	81	61	60	61
29	5	8	7	65	67	66	94	100	97	97	100	99	73	73	73
83	5	4	5	42	38	40	56	59	58	69	77	81	48	48	48
5	10	36	25	80	79	80	94	93	94	97	91	94	78	78	78
92	5	8	7	68	56	62	79	87	83	77	80	79	64	61	65
84	5	24	16	77	82	80	94	100	97	100	100	100	77	72	75
59	5	16	11	74	76	75	85	90	88	94	91	93	72	72	72
76	5	12	9	77	82	80	100	97	83	86	100	93	75	77	76
60	5	20	14	80	82	82	97	97	97	100	94	97	79	77	78
3	10	20	16	68	58	63	71	72	71	74	80	77	61	60	61
74	5	20	14	68	56	62	88	93	91	94	91	93	71	68	70
62	5	8	7	61	62	62	82	72	77	91	89	90	67	61	64
99	5	0	2	23	18	20	26	12	20	26	14	20	18	12	15
24	10	24	18	84	85	85	100	100	100	100	100	100	82	81	81
7	5	32	20	74	29	77	100	100	100	100	100	100	78	81	80
98	10	12	11	58	56	57	74	65	70	94	86	90	66	60	62
37	5	16	11	42	12	26	56	41	48	49	65	57	42	35	38
58	5	20	14	77	67	72	97	100	83	100	100	100	78	75	77
2	10	24	18	74	79	77	100	100	100	97	100	99	78	79	79
46	5	20	14	84	82	83	100	100	100	100	97	99	78	79	80
70	5	36	23	71	85	78	100	100	100	100	100	100	77	83	80
85	5	20	14	61	64	63	82	62	73	86	77	81	66	59	62

TABLE 2 (*continued*)

Chart	Kindergarten			First Grade			Second Grade			Third Grade			Totals		
	M	*F*	*M+F*	*M*	*F*	*M+F*	*M*	*F*	*M+F*	*M*	*F*	*M*+F	*M*	*F*	*M+F*
38	5	24	16	79	82	80	100	100	100	100	94	97	90	79	79
56	5	4	5	61	47	54	58	87	73	89	89	89	60	60	60
39	5	0	2	46	44	46	67	68	68	74	80	70	55	52	53
22	10	28	20	80	82	82	100	100	100	100	100	100	81	81	81
80	5	24	16	79	85	82	100	100	100	100	100	100	79	81	80
36	5	24	16	80	82	82	100	100	100	97	100	99	79	80	80
52	10	28	18	80	79	82	100	100	100	97	94	96	80	80	79
28	5	16	11	74	82	78	91	100	95	94	100	97	74	70	76
79	5	16	11	65	71	68	91	91	91	94	89	91	80	69	75
32	10	28	20	80	85	83	100	100	100	100	100	100	81	74	77
63	5	8	7	55	41	48	71	75	73	77	77	77	58	53	56
47	5	32	20	71	79	75	97	100	83	100	100	100	76	81	79
96	5	8	7	65	53	58	88	81	85	89	91	90	69	62	65
4	10	36	25	80	85	83	100	100	100	100	100	100	81	83	45
50	10	32	23	80	79	82	97	100	83	100	94	97	80	79	80
25	10	20	16	80	85	83	97	93	95	94	91	93	78	76	77
93	5	20	14	65	62	63	82	87	85	94	94	94	69	69	69
69	5	12	9	58	64	62	76	62	70	89	74	85	64	56	60
33	5	8	7	45	41	43	29	31	30	49	51	41	35	35	35
68	5	16	11	68	76	72	100	96	83	91	89	99	74	73	73
57	5	20	14	71	73	72	91	93	92	100	89	94	75	72	73
23	10	28	20	79	79	78	88	84	86	94	83	84	75	71	73
40	10	36	25	79	82	80	100	100	100	100	100	19	80	83	81
54	10	32	23	79	79	78	94	96	95	97	97	97	77	79	78
7	5	12	9	52	67	60	85	87	86	83	79	70	63	64	64
88	5	12	9	74	76	75	85	93	89	86	89	97	70	71	71
65	0	12	7	71	64	68	82	90	86	97	86	91	71	67	69

for. Such an analysis is available in Table 3. With regard to naming, approximately 90 per cent of our kindergarten *S*'s failed all three plates

We find that about 40 per cent of first graders fail all these diagnostic plates as compared with 30 per cent of second graders and 17 per cent of third graders Should we talk in terms of color blindness as defined by Dvorine (namely missing one of these diagnostic plates) then practically all our subjects are color blind. In the kindergarten group, approximately 98 per cent; in the first grade, 94 per cent, in the second grade, 85 per cent;

TABLE 3

SHOWING NUMBER OF *S*'S NAMING ZERO ONE TWO, OR THREE OF THE THREE DVORINE PLATES MOST DIAGNOSTIC OF COLOR BLINDNESS (PLATES 2, 3, 4)

No plates passed	Male No *S*'s	Male % *S*'s	Female No *S*'s	Female % *S*'s	No. plates passed	Male No *S*'s	Male % *S*'s	Female No *S*'s	Female % *S*'s
	Kindergarten					First Grade			
3	1	5%	0	0%	3	2	6%	2	6%
2	0	0%	1	4%	2	8	26%	10	29%
1	1	5%	1	4%	1	9	29%	7	21%
0	17	90%	23	92%	0	12	39%	15	44%
—	19	100%	25	100%	—	31	100%	34	100%
	Second Grade					Third Grade			
3	5	15%	5	16%	3	9	25%	8	23%
2	9	26%	9	28%	2	10	29%	9	26%
1	8	24%	10	31%	1	10	29%	12	34%
0	12	35%	8	25%	0	6	17%	6	17%
—	34	100%	32	100%	—	35	100%	35	100%

and in the third grade, 75 per cent of *S*'s are "color blind." Such sex differences as exist, ranging from minor to insignificant ones, favor males about as often as females

We have indicated that, according to the Dvorine Test, 75 per cent of our third grade sample was diagnosed as color blind by their failure to pass the three most sensitive plates. Let us follow that 75 per cent of our third grade group and observe their responses to plates with differing figures but with the same color combinations as in the charts failed. Table 4 shows this analysis. The reader will note how inconsistently these same subjects perform on similarly colored plates. Thus, 86 per cent of the 15 males and 69 per cent of the 16 females who failed plate "95" successfully passed Plates "5" and "79" employing the *same* color combinations.

As concerns Chart "26," with red 2 on gray background and blue 6 with violet ground, 88 per cent of 17 third-grade males and 81 per cent of third-

TABLE 4

SHOWING HOW THIRD GRADE MALE AND FEMALE *S*'S WHO FAILED "DIAGNOSTIC" PLATES PERFORM ON OTHER PLATES IN THE DVORINE TEST UTILIZING THE SAME COLOR COMBINATIONS

Diagnostic plate failed	Matching plate	Responses to matching plates	Male		Female	
			No *S*'s	% *S*'s	No *S*'s	% *S*'s
95 Rd & Bn Gn & Or	5 Rd & Bn 79 Gn & Or	Both Correct	13	86%	11	69%
		One Correct	1	7%	5	31%
		None Correct	1	7%	0	0%
		Total	15	100%	16	100%
26 Rd & Gy Bl & Vt	84 Rd & Gy 56 Bl & Vt	Both Correct	15	88%	17	81%
		One Correct	2	12%	4	19%
		None Correct	0	0%	0	0%
		Total	17	100%	21	100%
8 Bl-gn & Or	46 Bl & Or 55 Bl & Gn 79 Gn & Or	All Correct	12	74%	10	71%
		Two Correct	2	13%	3	21%
		One Correct	2	13%	1	8%
		None Correct	0	0%	0	0%
		Total	16	100%	14	100%

grade females who failed this plate, passed Plate "84" (red digits on gray) *and* Plate "56" (blue digit on violet). Furthermore, 75 per cent of the males *and* 71 per cent of the females of the same sample who failed Plate "8" (blue and green on orange ground) successfully passed *all three plates* utilizing blue digits on orange, blue digits on green, and green digits on orange!

It will be recalled that the first two diagnostic charts employed digits of two different hues on backgrounds of two different hues. If such a chart is diagnostic of "color blindness," then one might expect our *S*'s to be successful on one of the plates with colors like those of the part of the complex diagnostic plate which he may have passed But when he *passes* a further set of test plates employing all the diagnostic plates that he *failed*, then "color blindness" is indeed an evanescent phenomenon Now you see it, now you don't! Note that approximately 75 per cent of this "color blind" group is not "color blind" by other plates in the series of the *same* color combinations

The construction of the Dvorine Tests prevents an analysis in terms of different digits holding color combinations constant, with the exception of the above analysis of the diagnostic plates which is complicated by the introduction of three or four colors on one plate. But if color perception is an absolute affair of discriminating a hue *per se* rather than interrelationship of colored *digits* and colored *backgrounds*, then there should be no radical upset in the results obtained where there is a reversal of figure-ground hues. But Table 5 shows a variety of differences in the percentages of *S*'s passing two plates with the color combinations reversed in the way indicated. The first column lists those charts selected on the basis of the fewest *S*'s passing them, which range from 15 to 57 per cent This is in contrast to the range of 60 to 77 per cent that pass plates where color combinations of figure and ground have been reversed although it is true that the shape of the digits is also a variable, perhaps the determining one.

We call especial attention to Plate "99" (green on yellow) with a 15 per cent pass as compared with Plate "62" (yellow on green) with the percentage passing this plate rising to 64 per cent. Other percentages vary from 7 to 25 per cent difference.

One other observation remains to be made about the data of this same table. An examination of the hue combinations in Column I shows no such striking contrasts as may be noted in other plates of the series Yet these are characteristically failed However, Column 4 with the same combinations in reversal are consistently passed by relatively high percentages of the same *S*'s. Since the only other variable is a difference in the digits, we suggest that digit shape may be an important factor in the kind of color perception tested here, although we realize that such a hypothesis can only be investigated experimentally. According to Dvorine (3, p. 132) his results show that . "when an individual with defective color discrimination failed the orange-green combination chart, he also failed the blue-purple chart as well; in no instance did anyone fail one chart and pass the other." With such clean-cut findings in his adult group, we have analyzed our data in order to see if the same rule applies to our young *S*'s. Reexamination of the individual record sheets shows that for those of our eight *S*'s in the first, second, and third grades who failed the orange-on-green chart (28), three or 38 per cent were nevertheless successful in the blue-on-violet chart (56). Of the 41 *S*'s who failed blue-on-violet (56), 36 or 88 per cent passed the orange-on-green plate (28).

Dvorine (3, p. 132) also states that among his office patients he found certain individuals that failed his (2) screening test. When these were examined on the lengthier Color Perception Testing charts, the same as those used in our study. "All of them showed the usual weakness for certain specific color combinations that are generally found in the so-called "color-blind" individuals. In no instance did a patient fail the screening test and later pass a more complicated and lengthy test." While it is true that we did not administer the screening test, we have nevertheless compared color combinations in the diagnostic charts employing the same hues as those of the screening charts with additional test charts of the same hues (cf. Table 4). It will be recalled that approximately 80 per cent of our *S*'s were successful on charts that matched hues of plates that they previously failed. A further analysis of plates with the hues of the two screening plates reveals contradictory results. From 33 to 82 per cent of *S*'s failing one plate were successful with another chart with same hues but in a reverse order. Instead of showing a specific color deficiency, results from our *S*'s indicate that the perception here tapped is itself a highly specific affair determined by relative proportions of component hues, figure-ground relationships, comparative areas of the two and, as we shall show, by the subject's previous and present experience with the specific digits shown.

In the case of the chart with green "79" on orange ground, 82 per cent of those failing were successful with orange "28" on green background. According to Dvorine, no *S* who failed "79" should pass on the "28" chart, yet 82 per cent of our *S*'s actually pass the latter plate. We have observed that sometimes *S* reported the former number as "74" indicating clearly in those instances that some failures on charts may be a function of a similarity of

TABLE 5

PLATES LEAST FREQUENTLY PASSED COMPARED WITH PLATES INVOLVING FIGURE GROUND HUE REVERSALS

Plate Digits	Plate Hues	% Pass	Complimentary plate Digits	Complimentary plate Hues	% Pass	% Diff.
87	Rd & Or	57	20	Or & Rd	71	14
83	Vt & Rd	48	29	Rd & Vt	73	25
99	Gn & Yl	15	62	Yl & Gn	64	49
37	Bn & Yl	38	98	Yl & Bn	62	24
39	Vt & Bl	53	56	Bl & Vt	60	07
63	Vt & Or	56	32	Or & Vt	77	21
33	Bn & Gn	35	69	Gn & Bn	60	25

digit shapes. In other cases, such digit confusions are not apparent but we believe that a delicate balance between hue and brightness contrast may be readily shifted toward easier or more difficult discrimination through simple reversal of figure-ground hues. Certainly, one cannot argue that in such cases the areas of the two hues have been kept constant. In still other cases, familiarity with numbers or this factor admixed with suspected contrast factors shows up in our protocols. Time after time, the observation was made in which our young *S*'s would confidently read a chart correctly and just as confidently report in response to other charts at random: "There's nothing there," proceeding immediately to the next chart without any hesitation. While our study was not designed to investigate all these interrelated factors, the need for such a study is clearly indicated.

We believe that the setting and other factors which we have stumbled across in the present study complement both our results for tint and shade naming responses as well as those for the charts which involve recognition of numbers and provide no support for the traditional theory of an inherent defectiveness showing a 10:1 ratio in favor of the females. As a matter of fact, there are studies antecedent to ours that permit interpretation of color perception as being just as historically determined as any other class of behavior

. Cook (1), for one, found that by the age of two years, children in his sample could match colors with an accuracy of 45 per cent and could name the four primary colors with an accuracy of 25 per cent, but by the age of six years these reactions were developed to an accuracy of 97 and 62 per cent respectively. Working with a somewhat more limited sample, Staples (6) observed infants ranging in age from 69 days to 24 months and found that the perception of differences in colored objects begins at about the age of three months.

More recently, Smith (5) employing *S*'s over a wide age range, found that color discrimination improves rapidly from 6 to 25 years and drops rapidly after 64. The more educated *S*'s and those with more color experience were superior. Of the *S*'s between five and 11 years of age, females were superior to males, but beyond 14 years males were superior in matching saturation and brightness Such age differences as were found were considered to be a function of attitudinal factors rather than a receptor physiology

In our opinion, the present study shows the same developmental trend as preceding investigations We find a gradual improvement in the performances of increasingly higher age groups here observed both in color naming and in discriminating colored numbers Indeed, we are in hearty agreement with Young's (8, p. 162) passage which we quote in full as a conclusion to the present study.

> Children are slow to distinguish and name colors. They do learn in time by discriminative action with respect to colors and by naming the differentiating experiences As late as entrance into the first grade, pupils often confuse red and orange, blue and violet, violet and purple In our culture most people learn, in school and outside, to name and distinguish the seven major colors, but it is well known that many never go beyond these broad categories Men in our societies are notoriously less well trained than women to distinguish fine hues and nuances in the color of clothes For most people colors, like other sensory-perceptual qualities, are linked to day-by-day judgments of concrete objects Only the expert tends to segregate these into fine discriminatory detail.

C. SUMMARY

The Dvorine Color Perception Testing Charts were administered to 254 *S*'s, 119 males and 126 females, distributed as whole samples of the kindergarten, first, second, and third grades of one school population. It was found that·

1 Color naming shows considerable confusion, particularly in the kindergarten group, and a developmental trend throughout the four grades, shade naming becoming somewhat stabilized at the first-grade level with tint names showing a more graduated and continuous growth.

2 Statistically significant sex differences are not obtained for any of the sex groups. This holds for both shade and tint responses. Such slight differences as do exist favor males in some instances and females in others. Furthermore, they approach a vanishing point in the fourth grade.

3. As regards perception of the charts with colored digits on colored

backgrounds, we again find a definite developmental trend indicated in successive age groups.

4. Statistically significant differences in colored digit perception do not appear for the sexes at any of the grade levels When we consider the relative performances of the sexes for all the charts, we find males superior in 35 cases out of a total possible of 59, females superior on 15 plates and the sexes matched on nine plates. Sex differences do not appear even in the reactions to the three most diagnostic plates (2, 3, and 4).

5. *S*'s who fail a chart with a certain color combination do not necessarily fail other plates with the same figure-ground hues nor do they necessarily pass those charts that are hue reversals of charts failed or vice-versa.

6 It is suggested that relative areas, brightnesses, hues, contrasts as well as degree of familiarity with the shapes of digits are some of the other functions of color perception as observed in our study.

7 These results are brought into line with other studies as indicative of a developmental interpretation of color perception or "color-blindness" rather than the traditional "inherent defect" theory.

D. COMMENTS BY DR ISRAEL DVORINE

The outstanding feature of the paper by Dr Pronko and his associates is the disclosure that color nomenclature and colored figure-background discrimination is progressive in its development in early life and that genetic laws pertaining to color vision are not applicable in the sexes in the ratios which we have been led to believe. One cannot help to conjecture, however, on the possibility that critical ratios may appreciably alter if this highly specialized form of mental activity is investigated still further with an adult group

Discussing the significance of failure to pass one or more of the three diagnostic plates, Nos 2, 3, and 4, Dr. Pronko states "Should we talk in terms of color blindness as defined by Dvorine (namely missing one of these diagnostic plates) then practically all our subjects are color blind In the kindergarten group, approximately 98 per cent, in the first grade, 94 per cent, in the second grade, 85 per cent; and in the third grade, 75 per cent of *S*'s are 'color blind'" I cannot find a statement of mine which would lead one to this conclusion. What I did say (1) "Charts 2, 3, and 4 are visible to patients who have normal color perception, but induce varied responses from those who have a defective color sense"

If we interpret "defective color sense" as representing, in this instance and under this particular form of testing, a difficulty in discriminating colored digits on a colored background of the same or approximately the same intensity, then failure to pass Charts 2, 3, and 4 is merely an indication that some form of weakness in discrimination is evident to warrant further and more specific tests to uncover the exact color combinations which give rise to this visual confusion.

I am convinced that many complexities of the visual behavior pattern besides form, hue, brightness, intensity, and previous experience with the test objects influence our findings Today I would say that if an individual failed to pass Charts 2, 3, and 4, it merely indicates a departure from the average visual behavior pattern relating to color and form discrimination when tested with pseudo-isochromatic charts.

The fact that many *S*'s passed subsequent charts having the same color combinations as Charts 2, 3, and 4 is not nearly as significant as the article makes it appear. There are eight different tints in Charts 2 and 3 and six different tints in Chart 4, while in all subsequent charts of volume one there are only four tints The number of failures to pass increases in proportion to the number of tints used in the charts. It is regretable that the 40 testing charts of volume two were not used in this experiment. Since there are only two tints to each chart in this volume, I feel certain that many *S*'s who failed to pass charts of volume one would have passed charts with the same color combinations of volume two

The statement that some *S*'s failed to pass certain color combinations and quite readily passed other charts which had the same color combinations but with a reversal of the figure-ground hues, is not an uncommon phenomenon I have observed it occasionally while making routine examinations I attribute it not only to the difference in the shape of the digits but to a dominance or preferential urge to fix a certain hue when it appears in combination with other hues Whatever the cause, a reversal in passing ability is merely another facet in the visual behavior pattern. It is significant that in Table 5 the smallest percentage of reversals occur in the blue-violet combination, where the difference in hues is small

The disturbing statement to me is the report that 38 per cent of the *S*'s who failed to pass the green-orange combination were successful with the blue-violet chart (56) This is contrary to my experience with an adult group I felt certain that my findings in respect to the green-orange and blue-violet combinations would hold good for any group I cannot account for it and my only consolation is that the figure 38 per cent does not appear so formidable when one recalls that the figure actually represents the responses of three pupils, none probably older than eight years The number is small enough to warrant the assumption that their failure to pass the green-orange combination could have been due to factors other than color discrimination.

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APPARATUS

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BLOCKWRITING: REGISTERING CHOICE AND REGISTERING RHYTHM*

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The device with platform and sliding frame described in this JOURNAL (2) can be used not only with blocks resting in individual compartments on inked material but with marking instruments such as the heavy marking crayon, the colored pencil, the lead pencil, and the fountain pen with conical point or with ball point which is held upright

The feed-roller, both knobs of which have notch and pawl, can be raised in the slots for the insertion of the sheet of paper, the frame, pulled by a weight, slides back at the end of the line on a single rod.

A plain or notched feed-roller is now supplemented by one or more notched slats which seem to the writer to have in terms of the typewriter the effect of tabulators, in terms of the loom, the effect of heddles; in terms of poetry, the effect of rhyme and rhythm

The device is intended for the use of the observer of behavior which is merely manipulative and imitative as well as for the use of the observer of behavior approaching aesthetic expression Perhaps devices for which this opens the way will be used with subjects who have varying degree of disability (5), physical handicap (6), or a combination of disabilities and handicaps.

The platform of the device is screwed to the table, leaving both hands free.

SPECIFICATIONS

1 *Pair of Supports*

The supports are made from a stick ½ in. thick, ¾ in. wide, leaving a base ⅜ in. wide (b, 2-B, Figure 2). The stick is grooved in the top ⅛ in. from the outer edge, and in the inside wall ⅛ in above the rabbet, lengthwise. It has a group of two to four crosswise grooves, ⅛ in apart

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within the group, at intervals of 2 in. (e, f, 2-B, Figure 2), (g, j, 2-C, Figure 2). The supports are 5½ in. or more in length

2. *Platform*

The basic platform measures 11 in. between rabbets which are ⅛ in deep, ⅛ in. wide. A movable cleat, recessed to avoid interference with the feed-roller, is used with paper less than 11 in. wide. (Upper right, Figure 1)

3 *Notched Slat, Lift, Guard*

The slat, 12¾ in. long, is cut from a strip 1 in. wide (11, Figure 2), the lift, 2 in. long or longer, from a strip ½ in wide or wider (10, Figure 2), the guard, 2 in. long or longer, from a strip ¼ in wide (12, Figure 2), all from wood ⅛ in. thick.

4 *Feed-Roller*

The feed-roller, 13 in long, is cut from a dowel ⅜ in. D (3, Figure 2) A section of rubber tube, attached with glue, encircles it close to the support (4, Figure 2).

5. *Knob and Pawl*

The knob, ¾ in D, rim included, is made from a spool halved crosswise. The notches, which ought to be cut while the rims are fastened together in opposition, are one or many, equally spaced or grouped. The pawl, 1³⁄₁₆ in long, is cut from a strip ⅛ in thick, ½ in. wide.

6 *Frame-Rod*

The frame-rod, a bicycle spoke, is bent at one end and it has a screw cap at the other end

7 *Blocks and Geometric Insets*

Blocks (Upper left, Figure 1) and geometric insets, if these are used, (Lower left, Figure 1) have configurations in rubber on the base.

8. *Sliding Frame*

The permanent frame-end, 1³⁄₁₆ in long, is cut from a piece of wood ¼ in thick, ½ in wide, which has crosswise grooves ⅛ in x ⅛ in. at intervals of ¹⁵⁄₁₆ in. (6, Figure 2). An additional detachable end-piece 1³⁄₁₆ in. long, is cut from a strip ⅛ in thick, ½ in. wide The side of the frame, 1⁵⁄₁₆ in long, is cut from this same strip.

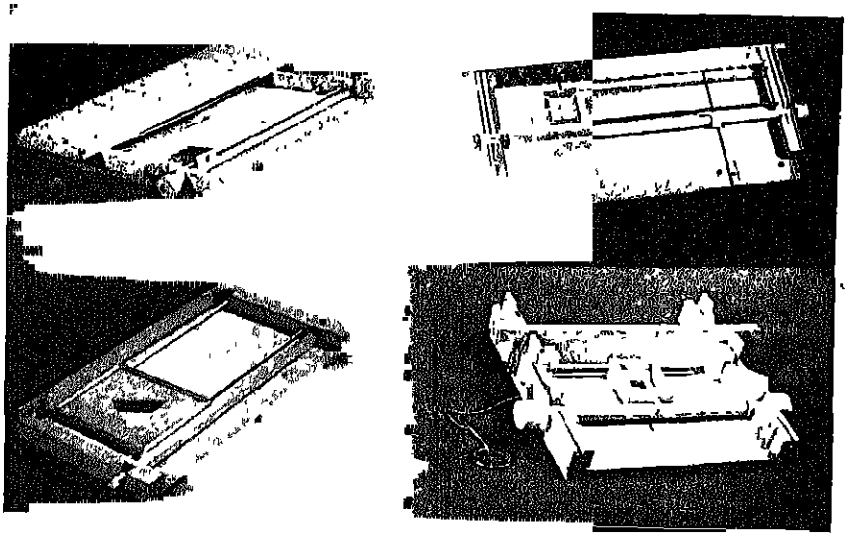

FIGURE 1

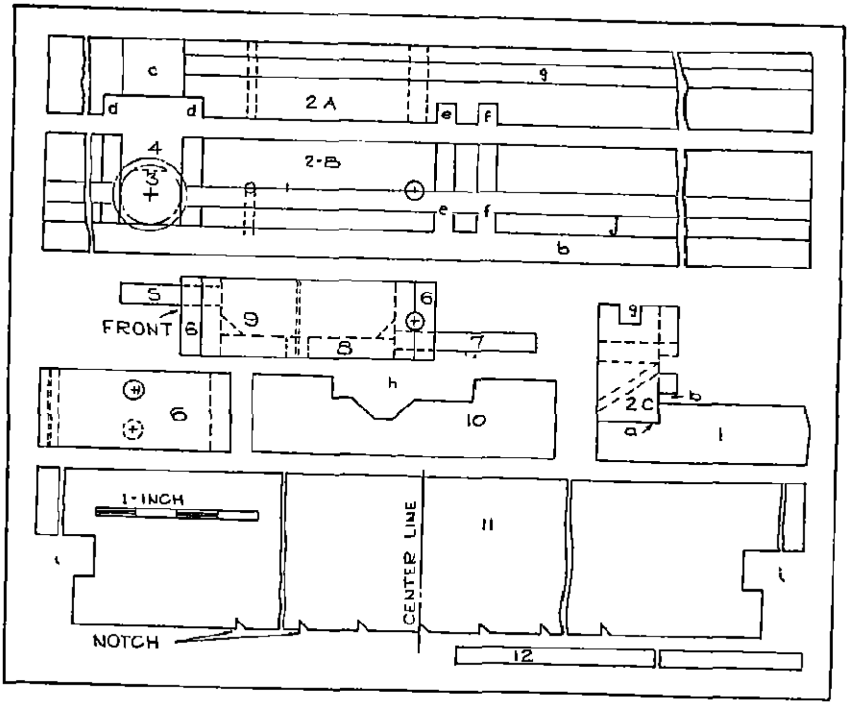

FIGURE 2

9. *Pawl of Sliding Frame*

The pawl with semicircular end is cut from a dowel ⅛ in. D. The pawl, ⅝ in long, which rests on the feed-roller (5, Figure 2) is set close to the top of the end, the pawl, ⅞ in. long, which fits the notch in the slat (7, Figure 2) is set close to the base, the left side of each cut away close to the frame-end The rectangular pawl with slanted end, is a square piece cut from a strip ⅛ in. thick, ½ in. wide. It is set with glue in a crosswise groove 1/16 in. deep, ⅛ in. wide, the left side of which is in the center line of the detachable end-piece. The pawl is easily cut if placed in the groove so that the grain of the wood is parallel with the groove (Upper right, Figure 1).

10. *Writing Cell*

The frame has a removable floor. The hole shown here (8, Figure 2) is for the introduction of the blade of a saw. An oblong rectangular hole is cut, to serve as a writing cell, which has sloping sides and slightly rounded corners.

11. *One-Piece Frame*

A one-piece frame which might be copied in transparent plastic has been cut from a block of wood ⅜ in. thick.

12. *Larger Frames*

All sizes of frames are cut from the same strips of wood, the pieces varying in length.

13. *Notched Feed-Roller for Work-Sheet*

a Select a feed-roller with an over-all circumference of 16 typewriter line-spaces and knobs which have one notch apiece.

b Place the feed-roller in the slots (*c*, 2-A, Figure 2) in the supports, attach the pawls at the required height and slip on the rubber bands

c. Make a downward cut in the top of the feed-roller 1/16 in. deep, 1⅜ in. from the left rabbet of the platform, joined by a slanting cut made 1/16 in. to the right of the first cut.

d. Repeat this notch at intervals of 1 in.

14 *Spacing of Work Sheet Blank on Typewriter*

a. Set the left margin stop at 1 in., the right margin stop at 7 in. plus three divisions of an inch to the right of the 7.

b Strike the apostrophe once, the underscore three times in succession.

c. Repeat this combination of marks at intervals of 1 in.

d Repeat this row at intervals of 16 typewriter line-spaces.

OPERATING

1 *Work Sheet Registering Choice*

a Push the work sheet under the raised feed-roller, keeping the left margin close to the left support, until the item to be copied appears just above the frame

b. Press the feed-roller down.

c. With block or other marking instrument copy inside the frame the item above the frame.

d. Move the frame from notch to notch with one hand while writing with the other.

e. At the end of the line release the frame by starting to turn the knob, allowing the frame to slide back to the left, then continue to turn the knob until it clicks.

f. At the end of the last line, raise the feed-roller and remove the paper

2. *Notched Slats· Registering Rhythm*

a Push the paper under the raised feed-roller until the top of the paper reaches the top of the sliding frame

b Press the feed-roller down.

c Make the required configuration inside the frame, moving the frame from notch to notch.

d At the end of the row release the frame by raising the slat for an instant only, clear of the pawl of the frame.

e. Turn the knob until it clicks.

f. Raise the old slat on to the higher step of the lift and drop the new slat down on the pawl of the frame

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BOOKS

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CRITICAL REVIEWS OF RECENT BOOKS

The Journal of Genetic Psychology, 1949, 74, 151-154.

(*Sherif, M., & Cantril, H. The Psychology of Ego-Involvements. New York: Wiley, 1947. Pp. 525.*

Reviewed by C. J. Adcock

This book does not fulfil the rich promise of the earlier publications of the authors. The alluring title leads one to expect that here will be a comprehensive development of the foundation laid in several papers in the *Psychological Review*. In fact, these papers, slightly elaborated, constitute the most important part of the book and the balance is a compilation from various sources designed to illustrate the general thesis. This material, gathered together in this way, is very useful but it leaves the impression that the authors have made no very vital contribution and that there is still some fundamental work to be done in disentangling the ramifications of the ego.

This criticism should not be taken to imply that we have not here a work of vital importance. The book is of considerable significance as a summary of the authors' work to date and its relationship to other research. The real contribution which we may expect from these writers is, however, still to come. In the introduction and again on page 114 we are promised this further contribution. Until it appears we can consider the present work only on its own merits.

The main thesis is that the ego is a genetically determined constellation of attitudes:

> Our major psychological activities—our perception, judgment, remembering, and so on—take place in referential frameworks. The ego is no exception. . . . We learn (or sometimes determine) what values, goals, standards, or norms are desirable for us. These become incorporated as *our* values, *our* goals. . . . These values, goals, standards, or norms . . . are represented by, set by, or created by group activities and social situations that form the constellation of social relationships with which we come in contact" (p. 114).

The genetic nature of the ego is generally agreed. What is chiefly at issue today is the content and mode of formation of the ego. We can agree that something in the nature of a reference frame is involved, but is this primarily cognitive or conective in its nature? We are told that the ego-attitudes are not "devoid of strong affective or purposive properties" (p. 101), but we are given no very clear account as to how they enter. The implication seems to be that our goals are established by social evaluations These, in turn, are determined by primary drives.

This leaves us to conclude that it is these same primary drives, operating in the individual, which lead him to be concerned about group evaluation The group is of significance to him only in so far as it conditions the satisfaction of primary drives "which have some definite and localizable anatomical or physiological place in the organism." We should expect the ego, therefore, to be a set of cunning attitudes designed to manipulate the group for the satisfaction of primary drives But it is from the group that we learn what goals are desirable! Surely there is some confusion about the nature of motivation.

Stressed throughout the book is the fact that the individual strives to enhance his ego, to raise his group status. Status becomes more important than the satisfaction of any primary drive. It would appear that we have successfully raised ourselves by our bootlaces!

To this reviewer it would appear that the fundamental mistake made here is the old atomistic one In the motivational field it is still thought that we can derive the general from the particulars. We are given a number of orectic bricks and told to build the ego. As against this view it may be urged that the individual drives, as we know them, are phylogenetically differentiated from something more general, call it what you will. Sherif and Cantril would, no doubt, at once label such a suggestion as "metaphysical" and therefore not to be considered, but if psychologists are to let prejudice divert them in this way it is time we examined our own reference frames. Allport, who takes up a position in many respects similar to that of the authors of this book is at least prepared to "let egoism with its conscious accompaniment of self esteem be admitted as an initial principle of life" (*Personality*, p. 171).

The recognition of a source of motivation outside the primary drives would have simplified the authors' task in several respects. We might have found a more adequate distinction between ego-involved behavior and other forms of behavior One is left with a confused impression that practically *all* behavior is ego-involved and a very useful distinction is obscured.

The rôle of conceptualization of the self is several times referred to but its significance is never brought out very clearly. McDougall's classic treatment of the sentiment of self-regard is ignored, although there is a reference to his instinct theory and a quotation from his *Abnormal Psychology* The

Freudian approach is reserved for the last chapter and is rejected because "psychoanalysis does not meet the test of scientific method" It would appear that the prisoner must have committed the crime because he has a bad record! The reviewer would have liked to see less space devoted to the debunking of psychoanalysis (which has been well done elsewhere) and more devoted to the concepts of the ego and super-ego The process of introception has too much in common with the thesis of this book to be lightly ignored. Despite the basic weaknesses of psychoanalysis some of its theories may be suggestive.

Frequent reference is made to "level of aspiration" but there is no thorough-going attempt to link this up with the concept of the self. We seem to have nothing to substitute for a presumably unacceptable "Ego-ideal" No doubt this is one of the things for which we must wait in a later publication, since it is implicit in the whole treatment, but one is left with the feeling that too much superstructure has been attempted before the basic foundations have been laid Perhaps this is unfair criticism, due to the personal disappointment of the reviewer Allowance must be made for his reference frame!

The three chapters following the introduction deal comprehensively with attitudes. The development of reference frames as the result of perceptual experience is demonstrated from laboratory experiments and everyday life situations The influence of the social factor and its increasing importance with the reduction of direct factual data is well brought out

The next chapter is chiefly concerned to establish that ego-striving is not instinctive This has already been criticized but it should be noted that much of the chapter is quite acceptable, e g., the genetic nature of the ego, the absence of *specific* ego drives, and the breakdown of the ego under stress

Chapter 7 deals specifically with experiments on ego-involvement. It is shown that in laboratory tasks and remembering there are significant differences when the ego is involved and that attitudes increase in intensity with increase of ego-involvement, but there is no adequate analysis of ego-involvement As against Allport it is argued that the ego is composed of social *and personal* values. The conclusion seems to follow that ego involvement is merely the degree to which the motivational system is involved As stated earlier this involves an undesirable broadening of the concept. It may be agreed, however, that the distinction of selfish vs unselfish is irrelevant to the definition of the ego.

A chapter on the genetic formation of the ego masses a wealth of material to confirm its genetic nature, but makes little attempt to examine systematically the mechanics of the process. Two chapters are devoted to adolescent developments, and here is stressed an aspect of ego development which is often neglected. This material should be familiar to all students of adolescent psychology.

Further chapters deal with ego identification in group and concrete situations and with ego breakdown. Finally we have some examples from literature and the chapter on the psychoanalytic approach already referred to

Despite the critical tone of this review the reviewer intends to make considerable use of the book in his teaching, and will await with interest the promised further contribution from the authors.

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The Journal of Genetic Psychology, 1949, 74, 155-159.

(Werner, H. Comparative Psychology of Mental Development (rev ed). New York. Follett, 1948 Pp 564.)

REVIEWED BY LOUISE BATES AMES

In *Comparative Psychology of Mental Development*, Heinz Werner makes a brilliant yet painstaking and well substantiated comparison between the structural principles of mental organization in children, primitive people, and certain psychotics. The mental activity of all of these groups he finds to be characterized by syncretism, synaesthesia, diffusion, animism, and magic. However, though formal similarities between these three groups are suggested, he warns against identifying the child of our own cultural sphere with primitive man at any cultural level whatever, since the child is a growing, labile organism whereas the behavior of primitive man is completely developed and fixed in tradition. Further, the child's behavior results from an interaction between his own world and that of the adult, whereas the primitive man lives permanently in his own world. Also the social pattern of the child is but vaguely organized whereas primitive man is socially conditioned and governed to the highest degree

Similarly, he points out, we must not identity the psychopath or psychotic with primitive man since the primitive man lives in a world to which he is well adjusted and this is not so with the psychopath Also the psychopath bears evidence of the more advanced stages from which he has retrogressed.

Before presenting data which will explain the nature of thinking at these three levels, i e., in the child, primitive man, and psychopath, Werner sets forth what he considers to be the main tasks and aims of developmental psychology· (*a*) to grasp the characteristic patterns of each genetic level, the structure peculiar to it, and (*b*) to establish the genetic relationship between these levels, the direction of development, and the formulation of any general tendency revealed in developmental relationship and direction. He states:

> "The final ambitious goal of experimental genetic research directed toward the analysis of organizational patterns is a comprehensive theory of ontogenetic phases", and suggests that though the various psychoanalytic interpretations "contain probably a greater amount of hypothetical elements than the available data warrant, they function as valuable stimulants in an area in which the danger of an overflow of research that lacks principle ideas is, perhaps, greater than in any other field of psychology"

He further points out that the concept of development is no longer assumed to be of a mechanistic order but is today oriented to an organic point of view "This means that each level is conceived organically and that the relationship between levels is organic in nature."

Werner notes that it was formerly conceived that mental development exhibited an unbroken mathematical continuity and that there is a gradual purely quantitative increase in the logical capacities of man as he moves toward a norm of mentality represented by the adult western mind. However,

> More recent investigations tend toward the belief that development cannot be symbolized by a continuous, mathematically conceived line but rather must be thought of in the form of typical mental patterns, with the relatively higher levels being understood as innovations emerging from the lower . Any level, however primitive it may be, represents a relatively closed, self-subsisting totality. Conversely, each higher level is fundamentally an innovation, and cannot be gained by merely adding certain characteristics to those determining the preceding level.

To begin with, the author discusses what he calls the *syncretic character of primitive organization*. Syncretic function, which according to him characterizes all primitive types of thinking (as found in the child, primitive man, psychopathic individual), he defines as one in which several mental functions or phenomena, which would appear as distinct from each other in a mature state of consciousness, are merged without differentiation into one activity or into one phenomenon. An example is the phenomenon of synaesthesia, in which there is a very close intersensory relationship so that a subject may, for example, see color while listening to tone. This like other aspects of primitive perception should not be understood as a bizarre and merely aberrent way of perceiving since it is bound up with the very development of the faculty of perception.

Sensori-motor and perceptual organization, at the primitive levels, is furthermore extremely *diffuse*, that is uniform and homogeneous with the parts relatively indistinct.

Primitive notions of space are discussed at length. They are shown to be syncretically bound up with the subject. Space for the primitive man is indissolubly linked with the individual personality and the tribal life and culture For the child, development of the spatial idea may be understood in terms of a gradual widening of the gap between the ego and the external world, an increasing objectivation,—space being originally one aspect of the child's consciousness of his body. Similarly in many varieties of mental disturbance, space becomes less objective and abstract than egocentric, affectively conditioned, and physiognomic-dynamic.

Primitive notions of time are similarly discussed as egocentric, concrete, and marked by an affective character-of-action, in contrast to the objective socialized time concepts of the mature civilized adult.

Primitive action is discussed as being primarily diffuse and characterized by mass activity and uncoördination. Experiments by students of infrahuman behavior are cited to confirm the theory that "behavior develops from the beginning through the progressive expansion of a perfectly integrated total pattern and the individuation within it of partial pattern." Also characteristic are a rigidity and a lack of plasticity in motive and goal, grounded in a comparative lack of polarity between the subject and the world. This polarity becomes gradually more defined and may be described as follows· "An ego that measures its ends and its powers ultimately stands opposed to an objectivity which enforces an adequately organized activity." But not so in the case of primitive activity where ego and world are not adequately differentiated.

Next comes a very thorough discussion of *Primitive Thought Processes*, made up of the following three chapters·

(*a*) A very long chapter on Conception discusses the fact that primitive activity is characterized by concrete and affective thinking in contrast to advanced forms of mental activity which are quite detached from the concrete sensori-motor perceptual and affective spheres. Concrete grouping is set forth as an analogous process of conceptual classification. Abstraction is found to occur first on a purely sensori-motor or sensory level

> "Primitive abstraction is a mental process closely allied to sensory organization Such an organization brings forth qualities whch do not stand out in isolation, but suffuse and dominate the totality." The process of transition from concrete abstraction to generalization is discussed.

The ontogenetic development of the naming process is aptly summarized as consisting of the following four steps.

(*a*) The name as a material property of the thing.
(*b*) The name as a concrete, physiognomic picture of the thing.
(*c*) The name as a physiognomic diagram of the (abstract) concept.
(*d*) The name as an algebraic symbol of the concept.

Similarly the primary development of number concepts is summarized as consisting of the following steps

(*a*) Level of qualitative configurations, substituting for number
(*b*) Level of concrete number-configurations.
(*c*) Level of concrete schematic numbers
(*d*) Level of abstract number concepts

(*b*). A chapter on the *Primary Structure of Thought* shows primitive thought to be concrete (and thus syncretic), diffuse, inconsistent, and labile in character. Primitive reflection means concrete configurations whereas typical European reflection is universal and abstract, functioning more or less independently of the immediate, concrete reality, and is governed by an awareness of general laws. The concrete and diffuse nature of the child's causal reasoning and logical inference, in particular, is illustrated.

(*c*). A chapter on the *Fundamental Ideas of Magic as an Expression of Primitive Conceptualization.* "The mental phenomena expressed in magic relationships and associations, the formation of concepts and abstractions in magic, the judgments and inferences of the magically dominated mind—all these show an origin in a syncretic and diffuse mode of thought." This is shown to be true both of primitive peoples and children, but just as with respect to other types of thinking, Werner does not identify the behavior of the primitive (or the psychopath) with that of the child. He cautions that we must take into account the differences between a fully developed magic as it appears among primitive people in whom it is a phenomenon oriented in terms of the culture pattern, and the magical tendencies of the child, for whom magic can occupy only an isolated position within a cultural sphere radically at variance with its intrinsic tendencies. It is pointed out that one of the most fundamental conditions for any magic form of behavior is the typical primitive syncretic unity of world and ego

A final section of the book deals with *The World and Personality,* and consists of two chapters, one on *Primitive Worlds and Spheres of Reality,* and one on *Primitive Personality.*

In *Primitive Worlds and Spheres of Reality,* Werner points out that the world must not be thought of as identical for all forms of life. The child's world, for instance, as opposed to the adult world, is a world of action, ego-centered and concrete. The structure of reality is physiognomic and pragmatic. Similarly the world of the primitive is shown to be primarily a world of action and of personal nearness, and that of the psychopath primarily egocentric and autistic. Though once again we are warned that though the spheres of reality for the psychopath resemble those of other primitive types in structure, they are fundamentally different in that they are pathological.

The final chapter, on *Primitive Personality,* suggests that the primitive man's awareness and formulations of his own personality and that of others reveal also characteristics of diffuseness and syncretism. Similarly the child's personality has a relatively diffuse and syncretic structure since the child's ego is more or less fused with the surrounding world. Increasing individuation occurs at the period of weaning, again during the "resistance period" of childhood, and at pubescence. Also there are shown to be pathological changes in personality which produce states exhibiting a structure which approximates in some respects a genuinely primitive personality.

Thus, perception and conception in child, primitive and psychopath are traced in their development from syncretic to discrete; from diffuse to articulated, from indefinite to definite, from rigid to flexible, from labile to stabile. But, throughout, the reader is reminded that the thinking of child and primitive, syncretic and diffuse as it may be, is not to be considered as a mere departure from the more accurate and normal thinking of the adult civilized man, but as in itself an ordinary and normal mode of thinking at a level which merely has not yet developed to that plane of differentiation and abstraction characteristic of the adult civilized man It has definite form and integrity at its own level

This is a difficult book to review briefly. It is so thickly packed with interesting hypotheses all of which are amply illustrated with lively and colorful examples from the literature on children, primitive, and psychopaths that a reviewer finds the material difficult to condense. A review can scarcely do it justice. It should be read to be appreciated. Any reader will be well rewarded, though the reading is not always easy going, and the book is over lengthy.

Although the main theme is clearly stated and carefully illustrated, the structure of the total book seems complicated to the point that it is difficult to keep the total structure clearly in mind. However, the reader will find not only a wealth of suggestive theorizing which if he is in the field of developmental psychology himself will set him off on new experimenting of his own, but also a most enlightening sampling of much of the German experimental work in the field, with which many Americans are not familiar. Most important of all he finds here a total psychological structure into which a good deal of the hitherto somewhat unorganized work in this field can be included and from which it takes a new shape. The bibliography is admirably inclusive and brings to light studies in related fields many of which are new to the developmental psychologist

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Child Behavior, Animal Behavior, and Comparative Psychology

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The Journal of Genetic Psychology, 1949, **74**, 165-176

THE ROLE OF THE MODEL IN EXPLANATION*

Department of Psychology, Tulane University

IVAN D. LONDON

Fundamentally, all explanation proceeds in terms of models These may be of various kinds, with modular apparatus ranging from the mathematical rigor of the closely articulated symbolical, at the one extreme, to the free looseness of the suggestive metaphor and simile, at the other But no matter how constructed or arrived at, every model serves to bring order of some kind to nature or, rather, our comprehension of her. A consideration of the function of models in explanation can be of some value to the psychologist, especially in view of (*a*) the radical reorientation in the physical sciences as regards the question of what constitutes explanation, and (*b*) the recognition of the reality of divergence as a factor to contend with, thwarting, as it does, universal reduction to general law operative over long intervals of time (9, 14, 15).

Given the appearance of order in nature (and we must not overlook the subjective aspects of this statement, since man must first select from out nature's welter discrete items before he may demonstrate their orderliness), what does the rigorous theorist feel compelled to attempt? Basically, he may attempt two courses The one as pursued by classical physics; a second as cultivated by quantum theory

The first seeks a model whose every point is in one-to-one correspondence with a presumed "reality." Such were the mechanical models of old. Such were also their mathematical counterparts. This, of course, places a great restriction on the kind of models available for theory-construction. The second abandons the *ideal* of a one-to-one correspondence between model and "reality." Instead, it demands of its model only critical *punctate* correspondences between itself and the "reality" it attempts to comprehend into theory (7, 20).

We are, in passing, not to confuse these models with those diagrammatic representations which abound in psychology and which are rather sterile affairs For instance, if the olfactory prism were more than a cataloguing device or had more than mere representatory significance, a pursuit of the geometric consequences of the representation should lead to meaningful cor-

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respondences in the olfactory sphere. The fact that it does not keeps it from being a model except in the most trivial sense (18, p. 151).

It is important to note that given sequences of data do not of themselves constitute a model, at least not in any useful interpretation of the word. As Pearson (19) observes:

> . . . [Any] sequence of perceptions has to be compared with other sequences, classification and generalization have to follow; conceptions and ideas, pure products of the mind, must be formed, before a description can be given of a range of sequences which, by its conciseness and comprehensiveness, is worthy of the name of scientific law [in our terminology, model]

However, a great deal of theory in psychology does not meet these criteria and is essentially barren, being very much like the "theory" of time on the basis of a watch. Certain regularities may be noted, and one can tell time by one's watch without having a detailed knowledge of the mechanism of the watch-piece. For instance, the sun rises and we note it is, perhaps, 6:30 by the watch. The sun sets and we note that again it is approximately 6·30 by the watch. We assume then two cycles a day, an A.M. and a P.M., which become categories for classification. We need only to have our mechanism go awry, the seasons change, or for us to become geographical wanderers, to discern the essentially barren content of our "theory" To be of more than trivial significance, any embracive model or generalization in psychology must yield on appropriate specialization all the instances from which the generalization proceeded and must give, in addition, more than is contained in all those special instances.

Models in pre-quantum physics were under the necessity of reflecting nature through one-to-one correspondences whether or not these correspondences were *in principle* always observable In this sense, mathematical order cannot be said to be imposed on nature, but only uncovered. With the abandonment of this restriction, however, and with the substituted requirement of critical punctate correspondences which shall link only *actual* observations with disparate correlating points on a larger model, a prodigious increase in freedom of model construction becomes possible.

Dirac pertinently remarks:

> . Previously, it was always considered essential that there should be a detailed description of what is taking place in natural phenomena, and one used this description to calculate results comparable with experiment. . . [but] detailed description in the traditional sense is unnecessary and . . . impossible to establish. [The quantum mechanical]

> method [of modern physics] focuses attention on to the quantities which [alone] enter into experimental results, . . . [so that] various points in the calculation [do have] their counterparts in the physical process . . . [This] implies a much less complete connexion between the mathematics and the physics than one has in classical mechanics, and one might be disinclined to call it a description at all, [though] one may . . . consider it as an appropriate generalization of what one usually means by a description (4, pp 2-3)
>
> . . . [the] mathematical methods . . . in use in quantum mechanics are capable of direct interpretation only in terms of a hypothetical world differing very markedly from the actual one . . . all [they do] is provide a consistent means of calculating experimental results . . . , [from which we may conclude that] to have a description of Nature is philosophically satisfying, though not logically necessary, . . . (4, pp. 17-18).

Since mathematical construction is almost licentious as compared with the small number possible mechanically, it is not surprising that the free mathematical models should have taken over where before only the mathematical counterparts of the mechanical model held forth From this point of view it is actually possible for two radically different models to have the same critical punctate correspondences with observation. In this sense we may definitely say that it is man who imposes *mathematical* order and law on nature

We have no right to quarrel with the use of these freely constructed models. We may ask only this—how far will these conceptualizations be of service in enabling us briefly and pregnantly to encompass the details of our observations? The mathematical notion of a point, for instance, may be absolutely absurd in the world of actual experience, but how far along could we go without it? It is not true that, to be of service, every conception must have an experiential counterpart, precisely reflected in all its members It is well to remind ourselves that "science is only a shorthand description of nature and not nature itself" (19).

These considerations will be made almost self-evident by considering the following illustration. Suppose in Figure 1 a number of observations, well within the interval $\pi/_{6} < x < 5\,\pi/_{6}$, are made which fall along a straight line representing the functional relationship between two variables. According to the classical view only one law should be possible and its formulation should be equivalent to wresting it from nature. The straight line represents that law and, with the presumed one-to-one correspondence in mind, the mathematical model correlated to it is, let us say, a straight line parallel to the X-axis, such as $y = \pi/_{4}$ for all x's.

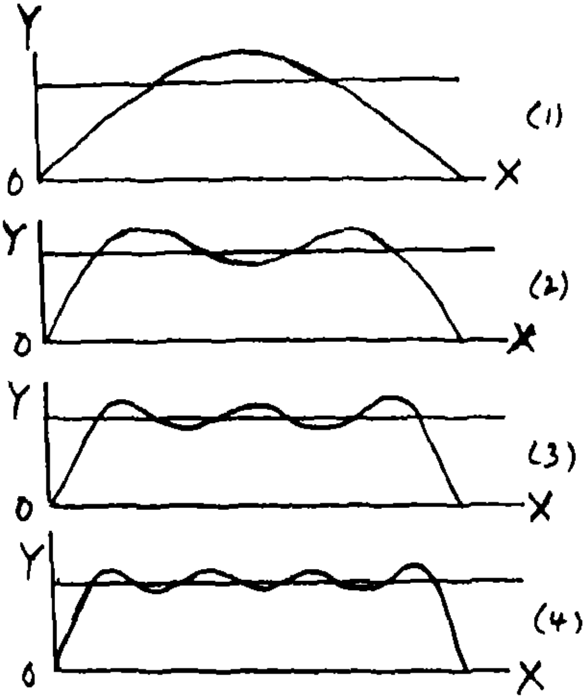

FIGURE 1

However, the great freedom of mathematical construction allows of yet another model of radically different design and implications and one which fits the data within the given interval as well or even better since data would never quite fall on the line in any case, but only thickly cluster about it That mathematical model is $y = \sin x - \frac{1}{3} \sin 3x + \frac{1}{5} \sin 5x - \frac{1}{7} \sin 7x + \ldots$ or more compactly, $y = \sum_{n=1}^{n=\infty} \frac{(-1)^{n+1}}{(2n-1)} \sin (2n-1) x$ (10, pp 76-77). A partial expansion of the summation will show the existence of a wave structure in the model and, hence, by transference an implied wave-like structural substratum for the phenomenon under our suppositious consideration Which model may we then say reflects "reality"; the one with or the one without wave structure? Or is the question perhaps unimportant?

It will be instructive to plot the first few successive partial summations of the indicated infinite trigonometric series in order to show how the value of the function, $y = \pi/4$, is quickly approximated and in the limit attained.

In the acompanying figures, the horizontal line represents $y = \pi/4$. The curve in (1) represents the first term or harmonic of the series. In (2) the curve represents a synthetic wave which is the result of summing the first two terms or harmonics In (3) the curve represents the sum of the first three terms; in (4) the sum of the first four

We readily discern from the figures how the continued summation of the terms gradually approximates to the straight line $y = \pi/4$, as the progressive summation of the terms in the series $y = \sum_{n=1}^{n=\infty} \frac{(-1)^{n+1}}{2n-1} \sin\,(2n-1)\,x$, brings about a continuous increase in the number of crests and troughs in the corresponding curve and concurrently a continuous decrease in the amplitude of the latter with respect to a limiting line

In other words, as the number of harmonics in our mathematical model is increased, the closer will the wavy thread twine around a limiting spindle, the straight line given by the equation $y = \pi/4$, so as to be in the limit *observationally* indistinguishable from it. However, the implications are different in as much as a wave-structure is implied (16).

For the psychologist one lesson, it seems, is especially to be discerned in this clear cut example—the danger of an incautious extrapolation of successful concepts beyond the limits for which they were devised and of too ready a willingness to give unqualified support to theories that are enthusiastic generalizations from limited observations in limited fields. A quick glance again at the figures will point up this warning at once, for, although in the middle region the two models give results indistinguishable in the limit from each other, to the left and to the right the results diverge widely and to the non-mathematician unexpectedly.

Which model, if any, will, therefore, be considered on an extended basis as adequate or "true," must depend on correspondences to be discerned in the extrapolated regions. For this enterprise we may almost look on our models as reflecting less "laws of nature" than "laws" for successful extrapolation from limited observations. The fact that our models agree with experimental data at all points where we can compare them and have thereby permitted us frequent rich penetration into the unknown should not blind us to the hazardous aspects of complete trust, on that basis, in the cleverness of our conceptual constructions and the sureness of our extrapolatory ventures.

Our discussion up to this point makes it perhaps easier to understand what it is that is meant when we hear it said that the scientist cannot be interested in the *why* of things, but only in the *how* His preoccupation with the *how* of things results from the fact that the *how* is that which he has deliberately contrived to regulate the behavior of his models and thereby univocally to assign the appropriate properties. The *why* escapes him, because the *how* reflects the inner mechanism, not of reality, but of his own arbitrary models The *how* reflects reality less than it does his method of grappling with it.[1]

The fact that we find ourselves asking *why* of human beings demonstrates no logical requirement that we put a similar query to nature. Our insistence, in this regard, is but another instance of lingual perseveration or transposition of verbal habits functioning with effectiveness in one field, here the social, to another remotely related.

When the scientist speaks in terms of the *why* of things, analysis will show either (*a*) that he is regressing from the simple constructs of the perceptual realm to the more generalized constructs of the world of conception; in which case he has not deserted the *how* formulation, but has made the *why* the regressive aspect of a process generalizing the *how*, that is to say, a continuing substitution, in finite regress, of one *how* by another more general, or (*b*) analysis will show that he is endowing his generalized constructs or models with an extraneous aura of sequential necessity merely for ease of discourse, a concession to his habits of daily speech and thought, as it were. But any necessity that can be demonstrated in either will turn out to be more a property of the symbols that articulate his models than of the "reality" after which these models are supposed to be patterned. The necessity, for instance, involved in the basic formula or model, $F = ma$, is merely one that is mathematical. Neither force nor acceleration precede each other as far as theory is concerned. Yet, we often speak of a force accelerating an object or a moving body exerting a force, even though actually in the formula an *a*causal relationship is made to obtain (13, pp. 270-271, 15, p. 173).

The classical physicist did not ask *why* the force of gravity should vary inversely as the square of the distance rather than its cube. Instead, he worked out his models for both contingencies and, since only the first could be set up in correspondence with observation, it was the former with which he dealt without further question

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[1] Pearson has pointed out that similarly the difficulties of the Zeno paradoxes stem not from the sequences of perception which we term motion, but from the conceptual models which we employ for describing it The notion of infinite spatial divisibility, involving such formidable abstractions as lines, points, etc, is a conceptual one which has no counterpart in the perceptual world, though its origin is of it; for it is the limit of processes begun in perception, but which cannot be completed in perception. The process of divisibility soon carries beyond the latter into the conceptual realm with no guarantee that the products of its symbolic operations there correspond at all to anything in "reality" (19).

As another instance, let us consider two definitions of potential in an electric field, and note the contrast between the *how* implicit in the first formulation and the *why* implicit in the second In mathematical language the potential at a point is defined as equal to the negative of the line integral of the electric intensity from infinity to the point (this is irrespective of the path followed, as can be demonstrated); or, $V = -\int E \cos \theta \, ds$, where θ is the angle between the direction of intensity and the path (22). This portrays succinctly for us a model which summarizes and regulates uniquely the relationships to obtain between the symbols and the corresponding entities they represent The *how* is here evident throughout.

On the adaptation of the above definition to *why* terms, we substitute for the neutralized items contained therein the kind of language which embodies those ideas and processes we intuitively accept or have come to feel at home with This is essentially what is done when an abstraction is given a physical interpretation; so that "physically" we may, therefore, define the potential at a point as the work done per unit charge against the force exerted by the field when a charge is brought from infinity (which is itself quite an idealized conception) to the point, a definition in which the *why* is every where implicit: Why must work be done? To enable movement to proceed against the force exerted by the field. The latter formulation of the definition cannot hold a candle to the former as regards fruitful development of theory and rigor.

Mention should be made of the so-called teleological constructs to be found in physics These involve such concepts as conditions of max- and minimality, "drift toward equilibrium" (8), constancy, etc., and seem to involve formulations exclusively in terms of *why* Why does a bubble assume the shape it does? So that its surface shall be a minimum. Why does a ray of light pursue the path it does? So that its time of travel shall be less than that for any other path. Why does an oscillating pendulum reverse direction at end of swing? Because kinetic energy + potential energy = constant and its K. E. is there zero and its P E. then at a maximum And so forth.

These *why* formulations can in every case be shown to be not only *equivalent* to, but actually *deducible* from, basic formulations expressed strictly in terms of *how* (11). As a first principle the *why* is illusory and appears either as a mathematical consequence of more fundamental constructions or shows up in such guise due to translation from the neutral symbols of theory into verbal terms of thereby facilitated discourse.[2]

Where generalized laws are impossible, as in the sharply diverging individual, it becomes even more pointless to apply the *why*, for there not even a model is possible. We can only record on a retrospective basis that such and such happened in such and such a sequence and attempt subjectively to synthesize from highly individualized and selected data the answer to what it is that makes the individual tick the way he does and perhaps to sense what the convergent[3] continuities of his past were that have imparted some consistency to his development.

Divergence excludes the possibility of total or, in some cases, even significant reduction of individual behavior to uniform generalizations and makes it again as pointless to ask precisely why an individual has traveled the particular path he has as it would be to inquire as to why some organisms in the remote past developed wings and others did not. In both cases we may record the divergent facts, but aside from the acknowledgement of the fortuitous accumulation of divergencies (in the guise of mutations in the latter instance) which did take place in certain directions, we cannot *in principle* hope to devise an unassailable explanation in terms of *why* and this because divergence makes impossible thoroughgoing uniform generalizations minutely or broadly applicable to each and every individual. Divergence lends partial anomy to man.

The fruitful application of statistical methods to the study of phenomena is dependent on a high degree of convergence, for then it is possible to set up statistical models for correlation and prediction of data. Langmuir states that:

> . [given a] scientific problem, involving convergent phenomena, . we are able to discover cause and effect relationships by an analysis of statistical data; [*e.g.*,] . our knowledge of stars by classifications involving large numbers of separate observations. Here we cannot experiment with stars but we can make hypotheses and test them by observations of increasing numbers of stars. (Personal communication)

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[2] Attention should be drawn in this connection to a recent theory of radiation (24) which represents an attempt to account for past events in terms of future events. The theory characteristically makes use of the free-invention of mathematics and involves, as one should expect, the complete abandonment of all "pictorialism" in the modular structure of its theory (3)

[3] Divergence refers essentially to the impossibility *in principle* of setting up or discerning *prognosticating* rational schemes or patterns for certain sequences of phenomena. Convergence refers to those situations where, contrariwise, this is possible (9, 15)

It was pointed out elsewhere (14) that:

> The psychological indeterminacy deriving from unpredictable [divergencies] is one that deals with . . isolated and unique event [s] which in [other] given psychological situation[s] cannot be duplicated or made to recur. . such indeterminacy cannot be made the basis of a systematic psychology, as a systematic science can deal only with the recurrencies of similar elements discernible in diverse phenomena . , quantum physics is able to establish mathematical patterns of such recurrencies in [its] probability distributions . . It can at will duplicate, as well as predict, these recurrencies. It is such recurrencies or regularities in the probability distributions of quantum physics which keep it a systematic and predicting science But . in the indeterminacy of psychology [there is] on the same fundamental level [no] analogously compelling condition which can allow the establishment of the essential regularities and consequent valid invocation of [an integrative] principle of indeterminacy as a basis for a systematic science of psychology

The possibility, then, of applying models to phenomena implies, at the very least, repetibility of probability distributions or a corresponding convergence Since so much of man is divergent and his individuality, hence, unique, such distributions frequently are not obtainable to play the decisive rôle that they do elsewhere, in other words, general models capable of a detailed non-retrospective accounting of personal behavior are not to be secured

On the basis of the preceding discussion, it is possible to take issue with those who hold that an essential difference does exist between explanation and description. In the nomothetic disciplines (1, p 22, 25) explanation *is* description, whether in terms of the mechanical one-to-one corresponding models of the classical physicist or in terms of the freely constructed punctate-corresponding models of the quantum physicist With this understanding we can almost assert the distinction between explanation and description to be one that is merely semantical.

Standards of "proof" and "explanation" in mathematics, physics, and elsewhere change and have changed with the ages. Proofs and explanations once accepted without question have been replaced now by proofs and explanations of men adhering to different standards of rigor and different criteria Even today the so-called "intuitionists" in mathematics deny the validity of whole sections of mathematics and are engaged in refashioning its bases in conformity to new criteria of validity there (2, 5, 6, 23) In physics, explanation is no longer equated to "reality" but to "generalized descriptions" in terms of freely constructed models in critical punctate correspondence with observation. *Explanation in the nomothetic disciplines is simply what is acceptable by way of description in conformity to the arbitrary, evolving standards of the times.*

In the idiographic disciplines, where divergence plays a significant rôle, explanation is an admixture of description and tacit appeals to empathetic considerations and, hence, must admit both to frankly subjective elements and to change in intimate progress with the divergence of events. We have elsewhere pointed out (15) that in the disciplines, which are predominantly idiographic, explanation is such that only *those* events that in the present feel significant will forge from out the past those causal chains of events of which they are the last links. This implies (*a*) that a theory of selection of past significant events, to be put into operation for the explanation of the present, must be preeminently a subjective one, keyed to present temper, and (*b*) that this theory of selection and its "law" of successive application from the past down into the present must constitute the idiographicist's system of explanation in assisting conjunction with constructions (e.g., complexes, mental states, social climate, labor movement) whose elements are the selected events. The particular theory of selection employed and the auxiliary constructions devised to facilitate its application do not exhibit a relationship that veers toward the mutually exclusive, but intimately direct and reinforce each other.

According to this view, the present becomes the criterion of the past, and the idiographicist, an analyzer, who sees the past through the eyes of the present The complex reverberations of the past are seen, therefore, to be selectively filtered and magnified into "causal" factors in the specially constructed resonators which the idiographicist, on an empathetic basis, has designed to analyze the past, in much the same way as the physicist employs resonators to study and analyze complex tones into their simple components So it is that paradoxically the past resounds to the clang of the present and not the other way around; which fact forces also the conclusion that even here criteria of explanation must again change with the ages and the accompanying *Zeitgeist.*

Formerly, demons were summoned forth idiographically to explain the course of man's life; today our demons are more sly and sophisticated and conform to a more subtle standard than formerly. We accept or reject them according as we are or are not satisfied with the types of explanations which employ them. For example, to see phallic significance in a man's wish to be an architect and to profess to the acquirement thereby of deep insight into the sequence of his past actions and divination of the meaning of his life may to some feel satisfactory and seem the acme of explanation, but to others subscribing to different standards and responding empathetically otherwise such explanation may be nothing but the sheerest balderdash

It is noteworthy that this "illumination" of the past through the focus of that present to which this past diverged is frankly and non-apologetically recognized more and more openly by writers in the most idiographic of disciplines—history Schlesinger, in commenting on his recent book (21), writes:

> *The Age of Jackson* grew out of two impulses, one historical, and one contemporary A few reviewers have charged me with writing an apologia for the New Deal I will say now that any resemblance between the age of Jackson and the New Deal is coincidental My single motive was to make sense out of what has always seemed to me a confused and confusing period of our history Yet it is probably true that *The Age of Jackson* could hardly have been written before the New Deal Each crisis of the present supplies new perspectives for the past, and the experience of the age of Roosevelt certainly provided vital leads for a reexamination of the age of Jackson.

The recognition of the contrived character and actual rôle of the model in explanation and the attendant subjectivity particularly evident in studies of the divergent aspects of man is one that is essential in a very real sense; for in psychology theories of divergent man in the fulness of his development always manage in one way or other to receive the stamp of some life-philosophy, no matter the "objectivity" of their claims

If those psychological models, which we have contrived to cover man, can suggest or be made effectively to implement working techniques of living, all the while conforming to certain "scientific" standards to which we have elected to adhere, we are indeed fortunate; for in practice these models are instigators of the future, not only modifying but creating its face But in all this lies danger, since, if we begin to take pronouncements in terms of our models too seriously or become too minutely logical about them, we risk forgetting that it is *we* who initially devised these models to function for specific purposes only and that there is, therefore, no automatic justification in allowing them to motivate us beyond that for which they were fashioned, merely because they happen to function successfully there.

Models in all their theoretical context must, of course, exert an influence on our lives and thinking. Nevertheless, it is well always to hold in mind that *we,* their artificers, are still their superiors, however much we delegate to them the power to influence and direct, a delegation that is the more fateful in accordance as it is in conformity to some theoretical scheme which surreptitiously espouses a philosophy of life, however the schematism take on the panoply of science

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THE CONCEPT OF THE BEHAVIORAL SPECTRUM*

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The reduction of behavior to lawful categories has long been the aim of psychological theorists and investigators. This reduction is essentially predicated on an all-pervading determinism which not only makes each event the product of antecedent conditions, but implies its expressibility in terms of them. To doubt this fundamental thesis is to some equivalent to a renunciation of the scientific approach to life and its problems

However, this need not at all follow. Moreover, the explicit and detailed reduction of individual behavior to primitive components, whose resultant, if only certain general laws could be applied, must be demonstrably equivalent to the aforesaid behavior, is more than somewhat questionable; for determinism, once thought firmly established by classical physics, has been shown to be merely a statistical effect anticipatable in large-scale phenomena (2, 6, 7)

The psychological animal, it seems, sports itself in a world that, in terms of space and time, is indeterministic, basically so Yet, in human affairs where, despite the enthusiasm of advocates, generally determinism is still a matter of implicit faith and belief, we seem very often to be able to predict and to guide the conduct of our affairs most satisfactorily on the assumption that the fates are deterministically biased and need ascertaining only in order that we be served by them.

Why the illusion of predictability can effectively obtain in situations where precision of forecast is either *in practice* or *in principle* impossible can be made understandable by introducing the concept of the behavioral spectrum. The illusion of predictability is managed by providing the forecaster with a set of probable behavioral events or outcomes (with or without associated frequency-indices), any one of which experience leads us to anticipate as a consequence of a given state and whose eventuation can under retrospective analysis be "validated" and "understood." It is this set of probable behavioral events that we propose to call the behavioral spectrum on the basis of the partially analogous rôle of the spectrum in quantum theory.

Preliminary to a discussion of the rôle of the behavioral spectrum in psy-

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chology, certain observations must be made in order to provide the contextual background against which the discussion is to proceed.

1. For us to determine the distributions or spectra of behavior to be employed in behavioral analysis on a general basis means in principle merely to (*a*) make ourselves familiar with all possible distributions of behavior, (*b*) classify them in suitable ways; that is to say, in ways suiting given purposes, (*c*) take account of their frequencies in any given spectrum, and in this way (*d*) be able to judge of the probability of certain features or characteristics of behavior turning up in a given situation. Not only the psychologist, but all of us in the course of daily life to a degree manage to do this and without question proceed with the business of living on this basis.

2. The questions that can arise for resolution under this concept are certainly of the most varied nature, and hence the behavioral spectra really needed in special problems can be also quite varied in kind especially in relation to exactness of prediction desired At one end of the scale we have the general question of finding out those features which are common to almost all possible behavioral states or behaving individuals so that we may safely conclude that those features almost always obtain. This is the *nomothetic* aim of the exact sciences. But at the other end of the scale we have such unique detailed questions as those which pertain to a given individual man in a particular one of his states where satisfactory prediction is often thwarted divergentwise and the *idiographic* conception of man comes inescapably to the fore (1, p. 22; 5, pp. 179-181; 10).

3. Convergence, as defined by Langmuir (4), implies the ultimate possibility of devising rational schemes for analysis of and imposition on phenomena such that, once devised, these schemes can be utilized not only for *discerning present* rational patterns in phenomena, but also with their aid for *deducing* from these prior discernments *subsequent* rational patterns to obtain among the evolving phenomena. Where an averaging-out process can be demonstrated among indeterminate elements, convergence creates the effect of an ineluctable determinism.

4 Divergence, as also defined by Langmuir (4), implies the impossibility of *deducing subsequent* rational patterns from *previously devised* schemes or patterns. It implies that all rational patterns that are found to be applicable among divergent phenomena have been devised for the occasion only and are *ad hoc,* that they invariably can be substantiated historically on a retrospective basis only, and that they are, therefore, subject to obligatory revision with advance into the divergent future(5). This must not by any means be taken as arrogating to the irrational a superior rôle to that of the rational. It

points merely to the importance of recognizing the very great rôle of the *non-rational* in life and living.

5. As has been amply and ably demonstrated in physics, rational schemes which are devised to cover phenomena consist fundamentally in setting up models which can be made to exhibit properties analogous to those of the phenomena which we have brought under observation. Since such models are abstractions formed for definite purposes, they are necessarily incomplete and, as long as we never confuse the phenomena under observation with the models devised to cover them, this incompletion in models is *not* necessarily a defect (provided we do not attempt a careless extrapolation) and ought not to bother us too much *as in no case can we grant ultimate validity to any of them;* for as Langmuir (3) has stated it. "We should . . . never ask whether the model represents reality. It is sufficient to say that in certain respects it corresponds to reality."

6. The symbols that we use, whether neutralized or unneutralized, that is to say, whether sharply delimited in definition or accompanied by an aura of elusive suggestibility, the models we use, whether rigorously conforming to scientific standards or diffuse and diversely suggestive as in empathetic metaphor, which, however ambiguous and sensually or emotionally toned, still is a model of sorts, all these may be capable of employment and manipulation in accordance with (*a*) the strictest rules of logic, or (*b*) special *non-logical*, but not necessarily illogical, rules of analysis, or (*c*) innumerable combinations thereof, so that analytical patterns can result which are rich in meaning and fruitful in practice, whether or no they are intrinsically susceptible of temporal extension (8, pp. 19-20).

Undeniably human behavior is complex and it is understandable why the failure to reduce it to a minute determinism should be ascribed to the complexity of that behavior, rather than to a probable untenability of determinism itself It is always easy to postulate a crypto-determinism which goes on the assumption that, if all the variables of human behavior were ascertainable, then it should be possible to devise an exactly predicting theory (9).

Because of the complexity of the human individual and his almost infinite variability, such theory is impossible Therefore, psychological theory of the divergent is forced to content itself with models or formulations which do not relate actual detailed behavior with subsequent detailed behavior. To attempt to do so would too easily show up the inadequacy of the theory. Instead, previous actual behavior is subjected to a classificatory process and selective underscoring of certain of its aspects, and then under the guidance of a retrospectively constituted causation linked to subsequent detailed behavior, likewise selectively classified within the framework of a supposedly deterministic theory.

Thus, when prediction is vouched for, it is not the particular item of behavior that is predicted, but the class to which it belongs (and that often a very tentative one) Instead of a single item of behavior, we are given a whole series of possible events in a behavioral spectrum, any one of which when fulfilled, will be said to have validated the choice of the given spectrum of behavior; that is to say, the prediction. It is sufficient merely to assign the class or spectrum of behavior to be anticipated in order to discern whether any given line of behavior fulfills expectations. In such a theoretical set up even intractable ambivalences become entirely acceptable and respectable. Thus it is possible to set up predictive categories so inclusive that within one behavioral spectrum the most varied and even contradictory lines of behavior may be contained.

In order to avoid specious predictivity such as this it may be that predictivity of psychological phenomena should be confined to *processes,* rather than to end results, as the greatest variety of terminations to behavior should be expected from the divergent effect of environment on the "primal forces" at work within the reacting individual. However, deterministic theory mediated through behavioral spectra, even though it profess to supply deterministic sequences on a theoretical basis and to provide well the little we ask of it, is only semantically so. It does not predict explicit behavior beyond class, which can be devised as conveniently as desired to suit the exigency of the moment and the theory that essays its explanation. Any failure in prediction of such kind, moreover, can be always readily ascribed to insufficient analysis of the situations involved and to unforeseen intervening factors and, hence, to the selection of the "wrong" behavioral spectrum.

For example, let us suppose that a certain woman's behavior after some analysis has been adjudged to be in general masculine, a descriptive designation loosely summarizing impressions and permitting us thereby tolerably to predict, on the basis of the presumed consistency of behavior, future reactions to given problematic situations. We are satisfied with our analysis if predictions are fulfilled. If not, we substitute a new classification; or, if we cling to the old, we look to ferret out "overlooked" alienating factors to account for deviation from expectations or we modify the classification with appropriate adjectives. To illustrate the latter practice, if compensation is indicated but inadequate to account for a given behavioral exhibition, we may often nicely resolve difficulties by discerning an *over*-compensation to account for the presumed exaggeration and deviation of response.

These tactics particularly characterize the application of deterministic theory to behavior that is markedly divergent and make somewhat questionable from the theoretical standpoint the "success" of such theory. Pragmatically, however, the procedure is quite valuable and is an extension and refinement of what we in our daily affairs normally pursue. For example, the clinical psychologist in any particular case forms ideas, impressions, and hypotheses on the basis of past clinical experience and the evolving immediate situation; so that, as each experience adds to the previous ones in an endless chain, he is enabled soon to reach some constructive conclusions concerning the case under consideration.

On the other hand, the best success to be predicted for the application of deterministic theory is in the field of behavior which is sharply convergent in character, *e.g.*, over long intervals of time for some types of psychotic behavior, but regularly only for short intervals of time for behavior of the normal individual, since for long intervals of time the latter, having undergone divergence, would often require too large a dosage of retrospective causation for an honestly deterministic formulation to obtain.

Through the medium of a most instructive analogy the rôle of the behavioral spectrum in analysis and prediction can be made more evident. Suppose we design a model in the customary fashion to represent a musical composition. We set up one-to-one correspondences between the temporal-aural phenomena, which we recognize as music, and certain points, distributed along 2-dimensional strips of paper in accordance with the arbitrary scheme of notation handed down by tradition. The model is constructed on a 2-dimensional pattern, the vertical dimension representing pitch, the horizontal time. This model is readily recognized as one whose correspondences are punctate, as not every geometric point on the 2-dimensional strips has significance for the musician, who is guided in his playing by this model—the kinds of marks used as well as their distribution along the strips helping to determine what punctate correspondences are meant.

Let us see what this signifies. First of all, the model has univocality, but only to a degree, for, if exactly followed, the music produced will sound wooden and unnatural. The function of the model is, evidently, also to suggest as well as precisely to guide The musician must supplement the model's incompleteness by bringing to it his artistry and interpretive skills. Secondly, its notational scheme is of necessity *stenographic* in contradistinction to those schemes, particularly in the exact sciences, which are *stenophrenic,* if we may be permitted to coin a word.[1]

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[1] I am indebted to the late Dr Albert Staniland who in the course of several conversations suggested to me both these two terms and the analogy to be discussed (8, pp. 21-22).

What precisely are we to understand by this distinction, which is by no means a trivial one? By a *stenographic* formulation we mean one which is in its very essence static, to be sure compactly indicating its intentions, but utterly incapable of lending itself to subsequent derivation. For instance, there is nothing in the notation of one bar of music to compel a given sequence of sounds in the succeeding bar. It is to be noted in passing, that successive and discontinuous stenographic formulations are markedly characteristic of the strongly divergent.

By a *stenophrenic* formulation we mean one which is in its very essence dynamic, also compact in its intended indications, but, contrariwise, containing implicit within its symbolism the very means of engineering subsequent derivations. Not only are correspondences indicated, but all the rules that the mind has devised for relating these given correspondences and *others,* not at the moment explicitly indicated, inhere within its compact representations; which significant fact accounts for the logic of coining "stenophrenic" as a term to cover what is, however we look at it, an amazing capacity.

For example, the mathematical equation or model, $d^2s/dt^2 = g$ (acceleration equals a constant), is stenophrenic because it not only describes a given fact, but does so in such a way as to allow a subsequent deduction of not only sequences of phenomena but even new formulas. As a matter of fact, on the application of two successive integrations to the above differential equation we can successively derive the formula for the velocity of a falling object at any given time and a formula which enables us to calculate the distance traversed by it within any given time interval.

As another example, the frequency-distributions which we generally encounter in psychology are stenographic in that their formulation is such as not to contain within itself the apparatus for subsequent derivations, requiring often, moreover, marked supplementary intercession from the outside before proper interpretation and application are possible The frequency distributions of quantum physics, on the other hand, are in general stenophrenic as they are so formulated as to contain within single compact representations the means and techniques for freely deriving subsequent distributions and often new formulas of great power and application.

Stenophrenic formulations generally are so much the mark of the convergent that, whenever any formulation of the latter is stenographic, we look on it as merely the expedient of the moment and regard the situation as temporary, unsatisfactory, and a challenge to more sophisticated reformulation, however useful the stenographic formulation may be; *e g ,* rule of thumb procedures, empirical equations or curve fitting, naive description, merely mechanical statistical tabulation, etc From this point of view we see also that reductionism is simply continuing stenophrenic extensionism.

Let us revert now to our musical model It is punctate in character and stenographic. Does this mean that in practice prediction is absolutely ruled out? Not quite, and for the following reasons. Great familiarity with *standard* music permits the musician on inspection of a few bars to say, "This is in the manner of Brahms, this Beethoven, this Wagner, and so forth." If we allow, then, a musician to inspect a few bars of music, concealing what follows, and ask him to hazard the probable sequences of sounds therein, his recognition that the music is Mozartian, let us say, in character will lead him to write out a number of alternative sequences of sounds which will be completely different from those which he might conjecture if he initially recognized the music to be that of Debussy It is evident that familiarity with music allows him to recognize the musical class to which a given piece belongs and then, on this basis, what probable musical sequences to anticipate, in other words, the musical spectrum.

We are now in the position to realize fully the exactly corresponding nature of the psychologist's attempt to handle the divergent successfully within a deterministic framework. Stenophrenic formulations are difficult for him to obtain or to apply. However, as a close student of life, he develops the ability to judge the behavioral class to which given behavior is to be referred and like a good artist supplements and interprets in his own way the incompleteness of its stenographic formulations This in turn permits him through symbolic schemes of one sort or other to set up the corresponding probable behavioral distribution or spectrum to obtain for predictive purposes The pursuit of any particular line of behavior actually presented to him in the behavioral spectrum will then be said to have fulfilled prediction; after which on a retrospective basis, *in toto* or *in parte,* he always manages to contrive some sort of "validating" analysis (5). Thus the concept of the behavioral spectrum allows us *in practice* to bridge somewhat the hiatus between the demands of our convergent-mindedness and the divergence of human events.

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RELATIONSHIPS BETWEEN COLLEGE APTITUDE AND DISCOURAGEMENT-BUOYANCY AMONG COLLEGE FRESHMEN: I. EXPERIMENTAL PROCEDURES*

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BERNICE MOODY HORRALL[1]

A. THE PROBLEM

1. *Introduction*

It was noted by the writer in recent Psychological Clinic work with Purdue University Freshmen that those of low college aptitude, as indicated by the American Council on Education Psychological Examination, experienced a great deal of emotional strain, bewilderment, and frustration resulting in discouragement and sometimes in extreme cases in depression. It is to be remembered that when people are placed in situations in which they do not succeed at least a part of the time their level of mental health is probably lowered.

The academic work at the University is presumably of such a nature that the large middle group in ability can succeed with a moderate amount of study and mental exertion while those in the upper ranges can succeed more easily Those at the lower levels, or those with the lowest college aptitude, are undoubtedly faced with a very difficult and in many cases insurmountable problem in the academic situation. Assignments and class work in English, Mathematics, Chemistry and other freshman subjects, which are prepared and understood with a moderate amount of work by the large group of students of average ability and with ease by the smaller number of above-average ability, seem of extreme difficulty and often beyond comprehension to those with the least ability.

In the opinion of the writer, while a State-supported institution of higher learning should perhaps on first consideration be held open and available to

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[1] The writer is deeply appreciative of the help and encouragement given by Professor Harriet E O'Shea in the undertaking and carrying through to completion of this study The writer is also indebted to Professor I. W Burr of the Mathematics Department for consultations concerning the statistical problems of this study The Division of Educational Reference made available funds for the purchase of tests used in the study, and supplied the mimeographing which was needed The writer wishes to thank Professor H H Remmers for making this help possible

all applicants, yet in the larger sense it should not open its portals to those young people who are bound to meet with failure and discouragement and consequently come to doubt their ability and real place in society. Some place earlier in the educational program a careful study could be made of their abilities and aptitudes and a wise program of vocational guidance might be made available so that each individual is placed in the situation where he can succeed, where he will not be faced with discouragement and frustration. Since such an ideal plan is not yet in force in most of our secondary schools, this university, as well as others over the country which have not set up rigid entrance requirements, is faced with the moral responsibility of dealing with the considerable number of entering freshmen who by their very lack of ability (college aptitude) are doomed to failure or extreme discouragement. Many drop out of the University sometime during the first semester; many others struggle through the first year at the insistence of their families or to avoid the disgrace they would feel in going back home and acknowledging defeat.

This study is an attempt to measure the observed discouragement of the group at the lowest part of the range on the American Council on Education Psychological Examination, in other words the relationship between college aptitude and discouragement. Samples were chosen from the middle and upper student groups on the American Council on Education Psychological Examination to serve as control groups to be compared with the low (experimental) group. The control groups were matched with the low group as to sex, school, membership in a social fraternity ("organized" or "unorganized"), and financial status, that is, earning money or being family supported.

2. *Previous Studies*

One of the first things noted in the preliminary work of selecting the subjects for this experiment was the number of students, especially those of low college aptitude, who dropped out of college during their freshman year. Coffey (3), in 1928, compared a group of 245 college freshmen in the upper fifth on College Aptitude Rating (a predictive measure reached by averaging percentile rank in high school graduation class with percentile score on College Aptitude Test) with a group of 236 college freshmen from the middle fifth on College Aptitude Rating to study student mortality at the University of Minnesota. The study was made after a 10-year interval Twenty-nine per cent of the high group and 76.6 per cent of the middle group did not complete their college course at the University of Minnesota.

No attempt was made to trace them to other schools. Seven per cent of the high group and 20.7 per cent of the middle group were dropped for low scholarship.

Although we have made no similar analysis of Freshmen at Purdue University, the trend seems in the same direction that Ruch (16) reported concerning 113 students in the lowest 10 per cent on the same test as shown in Table 1.

TABLE 1
RECORDS AT THE END OF THE FIRST SEMESTER OF THE UPPER AND LOWER TEN PER CENT (OF THE DISTRIBUTION OF INTELLIGENCE) IN A GROUP AT THE UNIVERSITY OF ILLINOIS

Record	Per cent of poorest tenth	Per cent of best tenth
Withdrew before the end of the semester	12	4
Were dropped by the university	24	0
Were placed on probation	37	2
Made average grades or better	10	84

Durea and Love (4) studied the personal problems of college students by giving a personal traits inventory to 304 freshmen (207 women and 97 men) from the College of Education, Ohio State University. They found very little correlation between the number and intensity of problems and the other variables of academic standards, intelligence (percentile rating on intelligence test derived from Ohio State University Psychological Examination), and admission blank score (an attempt to predict success of college freshmen). They found evidence that indicated that men on the average experienced more difficulties both in extent and intensity than women students.

In comparing earning with family-supported students, Hale (6) in 1934 found from ratings on the Bernreuter Personality Inventory that employed women students at Purdue University were less well-balanced emotionally, less gregarious, less sociable, and less dominant than women students who were not gainfully employed. She found that the average academic load and the average scholastic index of employed women were not appreciably lower than that of unemployed women students. The employed women did not make the social contacts they wanted to and probably needed. In her summary, Hale stated that, "The effect of employment is obviously on the experience and the personality of a student rather than on her health and academic standing".

The findings of the present study, although no differentiation was made between students working the minimum of four hours or much more, do not agree with the statement of Winston (23): "Students largely preoccupied with their financial situation cannot be expected to do classwork of as high a quality as they would with less drain upon their time and energy." He found that over a four-year period, 1934-1937, four-fifths of all freshmen (2,257 in number) at North Carolina State College reported the necessity of earning part or all of their expenses. Almost half of all students expected to earn at least 50 per cent of their expenses and one-tenth expected to earn the total amount. He suggested that class room hours be diminished, and extension of student aid or some other plan be established to take into account this problem Of the freshmen registering at North Carolina State College in the autumn of 1936 and 1937 only two-thirds had graduated from high school the preceding spring; almost one-fifth had graduated a year before entering college, and one out of seven had been out of high school from two to nine years. Hence there was a wide range of ages, and in that institution college freshmen were not a homogeneous group as to maturity and self-reliance.

Besides problems of economic insecurity and delayed matriculation, Winston (23) reported that 15 per cent of freshmen entering North Carolina State College in the fall of 1936 had no vocational preference and an additional 40 per cent were uncertain of their choice. Uncertainty of vocational preference was also noted in the present study, and the writer would agree with Winston that this points to a need for the highest type of vocational guidance in college and for increased guidance in high schools.

One of the implications of the findings of the present study would be that with wise vocational guidance in high schools, many or in fact all of the low ability students would be helped to find congenial work and satisfying social life in their communities rather than undergoing the discouragement of a college environment where it is almost, if not entirely, impossible for them to succeed comfortably. This idea is in agreement with the statement by Wile (22): "Freedom and responsibility, health and sanity, should be the goal for the greatest number of individuals, as well as for the State of which all are constituent members. This should be the essence of social planning—the heart of a corporate program to promote human values in terms of a social soul"

O'Shea (13) pointed out that from a mental hygienist's point of view one controlling criterion applying to exclusion from college is that, "A student whose ability to do abstract thinking is below that of the college level should not be allowed to face the inevitable failure attendant upon remaining in college." It was further stated that it is the opinion of the

Midwest Group of College Psychiatrists and Clinical Psychologists that a college should never dismiss a student with personal problems without making careful provision for his next experience As to the relatively large percentage of entering freshmen at Purdue University who do drop out of school during the first year, while the university does not actually dismiss them, yet the difficult academic situations at the university cause them to drop out; and, from the point of view of the Midwest Group of College Psychiatrists and Clinical Psychologists, it would still be the university's moral responsibility to help them re-establish their self-esteem The university does not and probably cannot conveniently follow these former students after they leave the university, presumably, therefore, it should raise barriers which will exclude other such students from the unwholesome experience of defeat and doubt of personal ability.

Harris (7) concluded in his review of the literature from 1930 to 1937 that, "It is the writer's opinion, unsupported by anything resembling a regression equation and based merely on his own findings, total immersion in the results and opinions of other investigators, and some cogitation, that the essential factors in student achievement are, in the order of their importance. (*a*) ability (or intelligence, or scholastic aptitude, etc), (*b*) effort (or drive, or degree of motivation, etc), (*c*) circumstances (personal, social, economic, academic, etc)"

In making the new scale used in this study, certain facts as found by Young (24) in her study of the problems involved in making questionnaires were kept in mind. She was concerned with situations in which the questionnaire was used as the sole instrument of study, but her findings undoubtedly apply to any questionnaire used in an experiment When anonymity is assured and when the subject is impressed with the sincerity of the experimenter, a relatively large number of people will respond Young stated that the wording should be simple and concise and easily understood by the least intelligent subjects for whom the questionnaire is intended Questions should be worded so as to avoid arousing of resentment, antagonism, or suspicion. Also the questionnaires should be interesting and seem important enough to justify the time spent in filling them out.

Several statements in the new scale were worded so that they would be true for freshmen in general and not apparently implicate the subject himself, as the one concerning discouragement among freshmen as a whole Huntley (8) found that strivings for self-esteem influenced self-judgment if the subject recognized that he was judging himself. Huntley recorded the mirrored writing, voice, clasped hands, etc, by picture or talking machine of two groups of subjects (without their knowledge) and six months later asked them to make judgments on their own forms of expression and those of others. Strivings for self-esteem as well as some feelings of insufficiency were usually expressed when subjects judged their own forms of expression without recognizing them. When they partially recognized their own forms of expression, their self-judgments were almost entirely favorable When they fully recognized their own expressions, their judgments became less favorable, perhaps because of the demands of modesty, but they were still always above average.

Traxler (19) pointed out that, since most personality inventories call for self-estimates, the question of the correctness with which individuals ordinarily make judgments concerning their own personality characteristics is an important question. He cited Tryon's experiment which showed that on the basis of a verbal portrait matching test there was a tendency for students to look more favorably upon their own personality qualities than their peers did, but that this tendency varied widely among the traits. He also reported on Spencer findings that only 43 per cent answered affirmatively when asked if they would have answered all questions truthfully and willingly if they had been required to sign their names.

Any study using questionnaires must take into account the likelihood that too much confidence should not be placed in questionnaire findings although they are apparently useful to indicate trends or tendencies or for group comparisons. Layman (10) gave two newly formed questionnaires dealing with personality traits gleaned from a critical analysis of 782 test items taken from 16 personality tests to 276 freshmen and 40 graduate students in physical education at the University of Iowa. She found that the same items were not checked on both lists by the same students, thus making the tests less reliable Her main problem was to attempt to locate separately recognizable "factors" being measured by the battery of test items In spite of the limitations imposed by the method and the small size of the groups, Layman concluded that. "The results are strongly suggestive that very few personality test items are such that they will present an adequately discriminative picture of an individual's behavior tendencies or personality 'traits'" She added that while this does not invalidate the tests themselves, counsellors and educators should realize their limitations and not put too great confidence in them. She also found that students said that they would not have checked some items if their identity had been known It was for this sort of reason that each student was assigned a code number in the present study to use on all papers rather than signing his name.

Some of the same points were considered in making the new scale on discouragement-buoyancy used in the present study as Kelly (9) pointed out in the construction of his 36-Trait Personality Rating Scale. His scale was of the graphic type in which each trait continuum was represented on a five-inch horizontal line Each line was marked with 25 divisions with "most people" at the middle point and an adjective or phrase describing each extreme placed at each end of the line He pointed out that perhaps it would have been desirable to have placed more verbal descriptions along the scale but that was found to be difficult. The same difficulty was encountered in making the discouragement-buoyancy scale but the verbal descriptions were made at the extremes and in the middle of the horizontal lines and only nine divisions were made Kelly also pointed out that since the scale was to be used by raters with little or no experience the directions were made as explicit as possible, a procedure which was followed also in the discouragement-buoyancy scale.

Pintner and Forlano (15) reported that· "There is no generally acceptable method for the validation of a psychological test. . Therefore, before launching upon the construction of tests or inventories seeking to measure personality traits or emotional attitudes, which though important are difficult of analysis and of determination and establishment of validity, attention might well be concentrated on the construction of techniques designed for the measurement of those personality traits more amenable to observation and follow-up" School teachers were asked to describe any outstanding personality characteristics of their pupils The teachers were not given a list of traits to be checked but simply made their own comments on whatever traits they wanted to mention. In somewhat the same way, friends and teachers might have been asked to describe the outstanding personality characteristics of the subjects in the present study, but in order to conserve time and to render the results more easily available for statistical manipulation it was decided to construct items worded as familiarly as possible for student use. Several college students were asked to help in wording the items

In considering the three levels of intelligence dealt with in the present study, the concept of level of aspiration is an interesting one when trying to determine the feelings of success or failure among college freshmen Frank (5) stated that. "A high level of aspiration may represent a direct expression of a goal, an incentive to better performance, or a means of protecting the ego. A low one may express an objective judgment, a method of avoiding tension, or a way of avoiding the appearance of failure."

Differences of intelligence were taken into account in the study of Washburne (20) in which the intelligence, home conditions, college activities and affiliations were ascertained for a group of 119 freshmen and 119 junior women at Syracuse University. The subjects were given the Washburne Social Adjustment Inventory which was a carefully validated test showing various phases of emotional and social behavior. Among his findings he reported that: "when the degree and number of differences in total social adjustment and in the subtests are considered, the girls who earn part of their way through college are the most superior of all the compared groups in nearly all phases of social and emotional adjustment. Whether work causes the social adjustment, or the superior adjustment causes the girls to be willing and able to work their way through college, or whether the causation is circular is a matter of speculation" He also found that: "Being in the upper 25 per cent of college students in intelligence is favorably related to some extent on the freshmen level with happiness, the sense of purpose, and a sense of self-regulation (control)."

In Washburne's study (20) he also reported that: "Being a junior (regardless of home conditions, college activities, *IQ*, or sorority membership) is associated with superior scores in total social adjustment and is very strongly associated with non-alienation (indicating a sense of social membership and acceptance, psychological security and emotional stability in social situations)." It is a well-known fact that the juniors are a selected group in that the weaker students have dropped out of school in many instances. This suggests the further possibility that being a freshman is a hard job in that the college situations are markedly different from those encountered in high school and in many cases the painful process of psychological weaning is being undergone. This points to the idea that those students poorly equipped as to college aptitude and abstract thinking should not be asked to compete in the academic college situation which even for the better equipped students is a challenge to their various abilities.

B. Experimental Procedures

1. *Traits to Be Measured and Tests Used*

a. Discouragement-Buoyancy—New Scale. A search of the literature did not reveal any scale which would measure directly discouragement-buoyancy resulting from current situations in the college environment. It was necessary, therefore, to construct a new scale intended to measure exactly the area which was under consideration for this study. A seven-item scale (nine steps to the item) of discouragement-buoyancy was finally evolved and was designated the Horrall College Experience Scale.

b Pessimism-Optimism—Chant-Myers The Chant-Myers Attitude Scale on Pessimism-Optimism offered a possibility of exploration in this field, but it seemed likely to be too gross a measurement, discriminating only great extremes This opinion was verified by the use of the scale in the battery of tests in this study.

Chant and Myers (2) defined the particular variable of personality they were studying as a continuum extending from an attitude of extreme elation or optimism to an attitude of extreme depression or pessimism, and constructed a scale of 22 statements to measure this attitude according to the Thurstone (18) technique This scale was used for measuring the defined variable in the following groups: (*a*) 300 undergraduates (average age: 20.5; *SD* 1.6, range, 18-27); (*b*) 117 unemployed men (average age: 29, *SD* 12 4, range, 19-47), (*c*) 123 mental hospital patients (average age: 45.3; *SD* 18.6, range, 23-70). The score for each subject was computed as the arithmetical average of the scale values of all the statements with which the subject indicated agreement by checking.

Chant and Myers found that the scores for the undergraduate group tended to mass at the upper or optimistic end of the scale They stated that.

> While the scale apparently provides for the adequate differentiation at the lower or pessimistic end, the degree of differentiation at the upper or optimistic end does not appear to be adequate for this (undergraduate) group of subjects This may be due to actual similarity of the student attitudes or it may be the result of an inadequacy of the scale at this end of the continuum While a revision of the scale with this weakness in mind is indicated, it should be recognized that this is not an unselected group of cases, and the skew obtained may be a legitimate reflection of the fact that these are younger adults who are living, for the most part, under very favorable circumstances

They found the average score for the undergraduate group to be 7 1, *SD* 1.17, with a correspondingly lower average of 6.1, *SD* 1 58 in the scores for unemployed men. They found a considerably larger percentage of cases at each extreme of the distribution for the mental hospital patients and accounted for it by the fact that among mental illnesses there are certain conditions such as manic-depressive psychoses which are known to be characteristically associated with extreme attitudes of depression or elation.

The Chant-Myers Scale to measure Optimism-Pessimism or Elation-Depression which was used in the present study was also one of the tests used by Whistler and Remmers (21) in their study of 150 men and 149 women undergraduate students (not freshmen) in psychology at Purdue

University in April, 1937. A part of their Table 6 is given in Table 2 dealing with the mean scores on the Chant-Myers Scale.

TABLE 2

Purdue	*N*	Mean	*SD*	SE_M
Men (self-estimates)	131	7.50	.89	.08
Women (self-estimates)	121	7.63	.84	.08
Ontario				
Toronto undergraduates	300	7.10	1.17	.07
Unemployed men	117	6.10	1.58	.15

Only 6.9 per cent of the men and 3.3 per cent of the women in the Purdue group scored at the neutral point, 5.5, or below. Ten per cent of college students, and 32 per cent of unemployed men scored at 5.5 or below in the Canadian Survey. The mean score for Purdue undergraduates was 7.56 represented by the scale statement, "*Life is quite satisfactory for me.*" Whistler and Remmers stated that: "Psychological percentiles have a low positive correlation, +.11±.06, with scores on the Chant-Myers Scale. There are 967 chances in 1,000 that the true correlation is greater than zero. There is thus some evidence that the more intelligent students are slightly happier than the less intelligent."

c. College Problems—Mooney Check List. The Mooney Problem Check List, College Form, presented a large list of items many of which were the opposite of others in the same category and which in any case was not scaled or standardized in a way to make it thoroughly useful for statistical analysis. However, the list seemed to offer such a comprehensive number of problems encountered by college students that it seemed of sufficient interest to be included in the group of tests to be given.

The Mooney Check List consists of 330 items grouped into 11 areas of college life and the student is to underline the items which suggest troubles (difficulties, worries) which he has. Then he is to look back over the items he has underlined and circle the numbers in front of the items which are of most concern to him.

Mooney (12) reported a dormitory survey made two months after the opening of school (November) of 171 *freshmen women at Ohio State University* by means of the Problem Check List, College Form. The average number of problems marked was 29.8 with a range from 3 to 106 Sixty per cent checked the item of not getting enough sleep, a problem which was also prevalent among Purdue University freshmen. Mooney pointed out that at least three major functions of the Problem Check List are: "It shows the most common problems among a group of students as directives to the kind of personnel services most in demand; it picks out particular students who are the most likely candidates for particular services, and it implements individual interviews."

d Ascendance-Submission—Allport Reaction Study. The Allport Ascendance-Submission Reaction Study seemed likely to be a measurement of more established personality traits and not likely to respond to current conditions of college success and failure. However, it seemed of general interest to determine how ascendant or submissive the subjects of the study were.

Ruggles and Allport (17) reported that various unpublished studies agree in finding a zero or negligible relationship between ascendance-submission and intelligence as measured by tests. Bender (1) found no significant correlation between intelligence scores of 192 sophomores, expressed in percentiles, and ascendance-submission scores.

e. Reading Ability—Thorndike-McCall Reading Scale. Because of the possible implications for understanding or lack of understanding of the other tests used in the study, it seemed interesting to ascertain the reading ability, especially of the group low in college aptitude. Therefore a simple standardized reading test devised to measure reading ability at the lower grade school levels as well as the college level was given, the Thorndike-McCall Reading Scale (Form 3)

2. *The Horrall College Experience Scale*

a. Construction of a Discouragement-Buoyancy Scale. In an effort to measure feelings of discouragement-buoyancy a scale was devised dealing with seven areas The item numbers given in parentheses below indicate the order of the items in the original trial 12-item scale from which the final seven-item scale was evolved. (*a*) Profiting from college (2), (*b*) Success this year (3); (*c*) Success after college (4); (*d*) Discouragement of freshmen in general (5), (*e*) Anticipated grades (7), (*f*) Living quarters (10), and (*g*) Treatment of students by the faculty (12).

The five areas of opinion which were discarded from the original 12 because they did not appear to measure the particular trait under study were· (*a*) Intensity of study (1), (*b*) Morals in college (6); (*c*) Making friends (8), (*d*) Warmth of friendships (9); (*e*) Personal attractiveness (11)

The order of items in the trial scale as presented to the subjects was. (*a*) Intensity of study, (*b*) Profiting from college, (*c*) Success this year, (*d*) Success after college; (*e*) Discouragement of freshmen in general; (*f*) Attitude toward college morals; (*g*) Anticipated grades; (*h*) Making friends; (*i*) Warmth of friendships; (*j*) Living quarters; (*k*) Personal attractiveness; (*l*) Treatment of students by the faculty. Great care was taken to arrange the items in the original scale in such a way that the opening statements probably would not arouse antagonism, and so that the items which were emotionally highly charged would be preceded and followed by those which would presumably not be much influenced by a halo effect from the emotionally charged items.

The scale was devised with nine steps on a horizontal line for each item. In order to facilitate the checking of spaces on horizontal lines, small boxes were spaced equi-distant along the line to indicate the steps. At the extreme left, the middle and the extreme right, the boxes were made slightly larger. Under the larger boxes at the extreme left and extreme right, statements worded in the first person singular were placed describing discouragement and buoyancy respectively. Under the middle box was a statement intended to describe the feeling intermediate between the two extremes. Careful directions and a detailed four-part illustration were given on the first page with instructions to the student to check the point on the scale where he thought he belonged.

b. Evaluation of the Horrall Scale by judges. An earlier form of the trial 12-item discouragement-buoyancy scale was presented to 33 judges (Purdue University staff members who taught freshmen classes or otherwise dealt with freshmen, and graduate students in psychology). They were asked to judge each item as to: (*a*) worth of item for this purpose; (*b*) consistency of each item; (*c*) order of items; (*d*) other suggestions. Responses were received from 28 staff members and graduate students in psychology and revisions were made on the basis of their judgments.

All of the items received such high favorable votes on (*a*) and (*b*) that none of the 12 items was excluded from the scale on the basis of the judges' reactions. The selection of the final seven-item scale was made later on the basis of the subjects' performance on the items. The judges' comments were utilized, however, in improving the wording of some of the items. Also one item, No. 12, which had originally been planned in a more elaborate way, was simplified at the judges' suggestion

The items in the trial 12-item scale were rated by the judges as to worth of the item for the purpose of this study (occasionally a judge did not react to every item so the number of judgments varies) (Table 3).

As to the consistency of each item, judgments of "inconsistent" numbered 2, 1, or 0 for all but three of the 12 items. Items (9) and (10) were judged inconsistent by three judges and Item (6) by four judges. Of these only Item (10) was retained in the final scale.

TABLE 3

Item	Number of judges placing each item in each category No good	Fair	Good
(*a*) *Items retained in the final seven-item scale (the item number in parentheses indicates the position of the item in the original trial scale)*			
1. Profiting from college (2)	1	7	20
2 Success this year (3)	2	4	22
3 Success after college (4)	3	7	17
4 Discouragement of freshmen in general (5)	0	4	23
5 Anticipated grades (7)	1	3	21
6 Living quarters (10)	0	4	22
7 Faculty members (12)	2	6	17
(*b*) *Items excluded from the final seven-item scale*			
1 Intensity of study (1)	0	4	23
2 College morals (6)	2	6	18
3. Making of friends (8)	0	4	22
4 Warmth of friendships (9)	0	3	23
5 Personal attractiveness (11)	0	5	20

3. *Selection of Subjects for the Experiment*

a. Experimental subjects (Low College Aptitude). All freshmen entering Purdue University in September, 1941 (with the exception of the foreign students) who ranked at or below the 10th percentile in the American Council on Education Psychological Examination and at or below the 30th percentile in the Purdue University Placement Test in English and in the Iowa Mathematics Training Test and who were still in the university by the middle of the second semester (April) constituted the experimental group.

The limits were set wider for the English and Mathematics Entrance Test scores because both of those tests are designed to be sensitive to training which the individual has previously received The Psychological Examination, on the other hand, is designed to exclude in so far as possible differences in training and experience and is intended to measure the individual's innate mental level. By assuming a low positive correlation between what is measured by the intelligence test and what is measured by the training tests, one arrives at the conclusion that the test scores in English and Mathematics should not be ignored in selecting the experimental and control groups, and that the limits of the groups can be wider in English and Mathematics than in the intelligence test scores and still give a group homogeneous with respect to what is essentially measured by the intelligence test.

Inasmuch as the purpose of the study was to measure the effect on the student of position in the group in college, it was necessary to conduct the study at a time of year which would allow the college environment to have operated for some time. The date chosen, April, insured the students having had one and one-half semesters of over-all college experience: classroom college activities, social life, and group living of one sort or another (boarding or rooming houses, fraternity houses or dormitories)

A startling fact came to light when it was found that by January 29, 1942 (the fourth week of the second semester) 23 per cent of the freshmen who would have been in the experimental group had dropped out of school (29 out of 126 students). There were only two more drop-outs of students in the experimental range by the middle of April when the tests were given

The experimental group in this study was then, presumably, selected on the basis of more buoyancy, less discouragement, than the percentage of the original group which had been lost by April. It would seem, therefore, that any findings of this study are distinctly conservative, that, were it possible to measure the drop-outs earlier in the year before they left the university, a deeper average discouragement would be disclosed than is revealed by the experimental subjects measured in this study.

b. Control subjects (Middle and High College Aptitude). As control groups for the experimental group described above, samples were chosen from the freshmen (*a*) in the middle ranks, and (*b*) in the high ranks in score on the American Council on Education Psychological Examination The control subjects were paired with the experimental subjects as to. (*a*) sex, (*b*) school at Purdue University, (*c*) membership in a social fraternity ("organized" or "unorganized"), and (*d*) financial status, that is, whether earning money or being family supported.

The seven schools at Purdue University were combined into four groups so that the work of analysis could be handled more easily since three schools were represented in the experimental group by numbers of three or less. School *W* was made up largely of one school to which were added two subjects from another small school whose course work was probably of about equal difficulty. School *X* was made up largely of one school to which were added one subject from one small school and three subjects from another small school whose course work seemed of similar difficulty to that from which the large number of subjects came School *Y* was made up of subjects from one school only as was also School *Z*.

It happened that School *Y* was the only one including both men and women students in the experimental group. School *W* and School *X* included only men students, and School *Z* was made up entirely of women students.

If a student was working four hours or more per week for pay, he was considered as "earning." This amount of work was decided upon because it was thought that four or more hours of work a week might affect the amount of time that could be spent on study or social recreation or the like and thus might conceivably affect the discouragement-buoyancy of the freshman student

The limits originally desired for the middle control group were from the 40th to the 60th percentile in the Psychological Examinations and from the 30th to the 70th percentile in the Purdue University Placement Test in English and in the Iowa Mathematics Training Test (all of which tests were given as Orientation Tests when the freshmen entered Purdue University) The limits for the high control group were to correspond in area exactly to the area studied at the low end of the distribution, namely, at and above the 90th percentile in the Psychological Examinations and at or above the 70th percentile in the English and Mathematics Entrance Examinations.

However, difficulties were encountered in the selection of the control groups according to the limits named above because in certain schools there was not a sufficient number of students within one or the other of these intelligence test limits to serve as a control group

A fundamental underlying assumption which is being examined in this study is that the individual's intelligence (high, middle or low) relative to the group in which he is functioning is the crucial issue in his adjustment rather than his "absolute" intelligence. At Purdue University a student takes most of his courses in groups segregated according to schools. It is the opinion of the experimenter, furthermore, based on a general inspection of the operation of student life at Purdue University, that students tend to live with others from their own academic school and tend to be grouped similarly in extra-curricular activities and in most phases of social life. It appears in other words, that for such questions as are being here studied there is in effect not one "Purdue University" but instead four separate functioning units (actually seven schools) only loosely joined and related to each other in student experience

In addition to the above assumption, it is further assumed that the level of difficulty of the work in the various classes will have adjusted itself automatically in the history of the institution to be comfortable for the middle 50 per cent around the mean of the college population. Apparently this translates into four recognizably different academic centers of gravity in the four experimental schools

The experimenter had not anticipated in advance that "absolute" intelligence would be so different in the four different experimental schools As this fact came to light it became necessary to refer to the underlying assumptions of the experiment in order to reach a decision as to how to select the control groups in the different schools. It was decided to adhere to the original underlying assumptions of the study and to select within each school the students who constituted the middle and upper portions of intelligence test scores in the distribution of that school regardless of where that placed the control groups in the total Purdue University distribution of intelligence (see Table 4).

In School *W* the original desired limits were rigidly conformed to.

TABLE 4
A. C. E. Psychological Examination Scores
(*L*—Experimental; *M*—Middle Control, *H*—High Control)

Percentile	School *W*			School *X*			School *Y*			School *Z*		
	L	*M*	*H*	*L*	*M*	*H*	*L*	*M*	*H*	*L*	*M*	*H*
98-100			8			2			2			1
95- 97			8			1			2			2
92- 94			4						1			5
89- 91			5									
86- 88						3						4
83- 85						2			1			3
80- 82												3
77- 79						1						2
74- 76						2						
71- 73						1						
68- 70						1						
65- 67						3						
62- 64						2						
59- 61						1					1	
56- 58		4						2			3	
53- 55		4			1						3	
50- 52		4						2			3	
47- 49		5			3						2	
44- 46		2			4			1			3	
41- 43					6						3	
38- 40		2			3						3	
35- 37					2							
32- 34					3							
29- 31					2							
26- 28												
23- 25												
20- 22												
17- 19												
14- 16												
11- 13												
8- 10	8			1						3		
5- 7	8			7			3			7		
2- 4	4			8			2			7		
0- 1	4			6						2		
Total	24	21	25	22	24	18	5	5	6	19	18	20

In School *X* it was found necessary to alter the control group limits on the basis of the above assumptions. This resulted in the limits for the middle control group in School *X* being between the 30th and 55th percentile in the Psychological Examinations and between the 8th and 88th percentile in the English Entrance Test and between the 9th and 76th percentile in the Mathematics Test. The high control group in School *X* included all above the 58th percentile in the Psychological Examination, above the 34th percentile in English, and above the 10th percentile in Mathematics.

In School *Y* the middle control group scores fell within the original limits for the middle group in all tests except for one student whose English score was 95 and Mathematics score was 19 The limit for the high group, however, had to be lowered to include all those above the 84th percentile in the Psychological Examination scores. The English and Mathematics score limits were conformed to as originally defined.

In School *Z* also, the middle control group was kept within the original limits in all tests. For the high control group the limit was lowered to include all above the 78th percentile in the Psychological Examination but kept above the original limit set for the English Test. No Mathematics Entrance Examination is required for students in this school.

This lowering of limits as described above was necessitated by the fact that there seemed no other way in which to match subjects in the experimental group as to school, since to use subjects from other schools whose subject matter was more difficult or easier would have been sacrificing one important factor in the study, namely, discouragement due to academic work. This lowering seemed justified in that the middle limits were still in the same relative position within the school group and likewise the high control group was still made up of the highest in the school group.

4. *Securing Subjects and Administration of Tests*

Letters were written to ask the subjects to cooperate in the experiment A note of approval and request for cooperation from the Dean of Women was included in each letter to a woman student, and a similar note from the Dean of Men in each letter to a man student A code number was included in each letter as well as a blank to be filled out and returned in a self-addressed stamped envelop to the experimenter indicating to which session the student would come. A plan of code numbers was arranged for convenience in sorting papers such that the individual's number indicated whether he was in the low, middle, or high group.

Four different hours for testing sessions were offered. Follow-up letters were sent to those who did not coöperate at the first group of meetings with self-addressed postal cards to check at which later hour they would come. Telephone calls were also made to get in touch with the remaining subjects who had not already responded.

The battery of tests was administered in a large, light, well-ventilated lecture room An easy, informal manner was used in the introductory remarks and in the administration of the tests. Explanations were kept identically the same at each meeting.

At the testing session the students were first of all thanked for coming and giving their time to help in this study. It was explained that similar studies had been made in other universities but never anything exactly like this at Purdue University and that their help might really make it easier for Freshmen entering the university in the future. It was explained that their code numbers were given to them so that their various papers could be kept together, that all answers would be recorded by number only, and that no one in authority at Purdue would ever see their reports, neither clinical assistants, deans, professors, or instructors.

The battery of tests was given in the following sequence:

1. A general information blank was first filled out

2. The Horrall Scale was then presented, the first page of instructions explained, and the students asked to check the practice items. The students were then instructed to proceed to the two following pages, checking as nearly as they could exactly how they felt about each item. Sufficient time was given for all students to complete the scale comfortably.

3 The Thorndike-McCall Reading Test was presented next. The test takes 30 minutes

4. It was then explained that the rest of the study was asking for the students' opinions. On the yellow folder (The Mooney College Problems Check List) they were to read the first and second parts of the instructions carefully and proceed as directed. They were told to raise their hands when they had finished the Mooney Check List and the next part would be brought to them. They were again thanked for helping in the study and the fact was pointed out that the more nearly they recorded exactly how they felt the more benefit and help there might be for incoming freshmen.

5. When each student finished the Mooney College Problems Check List he was handed the Allport *A-S* Reaction Study.

6. When the student raised his hand to indicate that he had completed the Allport Study, he was given the Chant-Myers Attitude Scale. Each student was free to leave when he had completed the Chant-Myers Scale

5 *Final Number of Experimental and Control Subjects*

Of the original 275 subjects who were invited to cooperate, 214 took the tests (71 in the experimental group, 71 in the middle group, and 72 in the high control group)

Nine subjects gave the following reasons for not coming: one had baseball practice, another football practice, two were too busy, four had to work, and one was in the hospital.

The 52 unaccounted-for may possibly represent some pronounced bias of sampling or they may have stayed away for reasons uncorrelated with the issues of this experiment.

The percentages of those invited who participated in the study are given in Table 5

TABLE 5

Group	Invited No	Participating No	Participating %
Experimental (Low)	95	71	74.7
Control—Middle	93	71	76.3
Control—High	87	72	82.8

There were originally 95 in the Middle-Control group, but it was found that one subject was a sophomore and one was a transfer student There were six less in the High-Control group because there were no subjects above the middle limits in one school to pair with the six in the Experimental and Middle-Control groups. It was also found that two of the 89 were sophomores.

As to the above shrinkage in numbers, it seems likely that the experimental subjects who stayed away were more discouraged than those who came It is possible also that those who stayed away in the middle and high groups were more discouraged than those who came. If so, all three samples have been affected alike and comparisons with respect to discouragement-buoyancy between intelligence levels have not been modified in any way by the self-sampling of the groups. Another possibility is that persons in the middle and high groups who stayed away, rather than being more discouraged, may simply have been more resistant to authority If absentees from the experimental (low) group were more discouraged and absentees from the control groups (middle and high) were absent for other reasons, then the findings presented below are over-conservative Finally it is also possible that absenteeism from all three groups was for random causes uncorrelated with factors measured in this study. It might be added here also that less follow-up work was required to get the cooperation of a sufficient number in the high group than for the other two.

Of the 214 who cooperated by taking the tests, a final number of 207 subjects was used for statistical analysis. One of the participating subjects was discarded because he was a foreign student, and three other subjects were discarded because their information blanks showed that they were either sophomores or transfer students. The other three were excess control subjects because the experimental number was reduced and these control cases fitted criteria limits less well than any of the others.

(*Continued*)

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RELATIONSHIPS BETWEEN COLLEGE APTITUDE AND DISCOURAGEMENT-BUOYANCY AMONG COLLEGE FRESHMEN: II. RESULTS AND INTERPRETATION OF FINDINGS*

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A. Results

1. *College Aptitude*

The distributions of intelligence test scores have been presented. The means and standard deviations of the intelligence test scores are now presented by schools. The reader is reminded of the fundamental assumptions of the study, namely, that position by intelligence in the total group within which one works is the crucial issue for adjustment and not one's "absolute" intelligence.

TABLE 1
ACE Psychological Examination Scores in Purdue University Percentiles

	Low (Experimental)		Middle Control		High Control	
	M		M		M	
Schools	σ_M	σ_{dist}	σ_M	σ_{dist}	σ_M	σ_{dist}
School *W*	5.79		50.52		95.52	
	.67	3.19	1.14	5.11	63	3.09
School *X*	3.64		40.83		74.28	
	52	2.38	1.28	6.17	2.58	10.63
School *Y*	5.00		51.40		94.33	
	90	1.80	2.10	4.20	2.25	5.03
School *Z*	4.84		50.17		87.65	
	67	2.82	1.34	5.52	1.38	5.99

As was explained in the discussion of the selection of the experimental and control groups, the original limits on the Psychological Examination scores were to be the 10th percentile and below for the experimental, with matched samples from the 40th to the 60th percentile for the middle control group, and the 90th percentile and above for the high control group. However, certain lowering of limits in the case of the middle and high groups in School *X*, and for the high groups in School *Y* and School *Z* was

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necessary although the same relative positions were maintained in the distribution for each school.

As will be noted in Table 1, the means for the four School groups of the experimental sample are very nearly the same. However, the mean for the middle group for School *X* is about 10 points lower than those of the three other schools, and the mean of the high group in the same School *X* is about 20 points lower than the means of the high groups in School *W* and School Y, and about 13 points lower than that of School *Z*. In all cases, however, the three groups within a school maintain approximately the same relative positions compared to each other and to the total distribution of the school. In the one case of School *X* the choice of control subjects was so limited that the bottom of the top group and the top of the middle group are closely adjacent. It is to be noted, however, that in School *X* the difference between the means of the high and the middle group is very nearly the same as the difference between the means of the middle group and the low group. In School Z, although the top and middle groups do not come so close together in their bottom and top extremes, these two means are a little closer together than the means of the low and middle groups of that school.

2. *Discouragement-Buoyancy and Intelligence*

Because no scale was available to measure discouragement-buoyancy of college freshmen, the Horrall College Experience Scale was constructed to sample their feelings in the various areas of student life that might reflect discouragement One of the basic questions of the study was, "Are the students at the lowest end of the distribution in college aptitude measurably more discouraged than those at the middle and top of the distribution?" Another question which arose but which was of secondary importance in the study was, "Are those students at the upper end of the distribution in college aptitude more or less buoyant than those in the middle of the distribution?"

Several staff members with whom the above questions were discussed gave various answers. One said that of course everyone knew that the students with the least ability were much more discouraged Another said that many with low ability simply came to college to have a good time, since going to college seemed the thing to do if one's parents could afford it. Another faculty member maintained that those of low ability could succeed academically if they studied hard enough., A brilliant graduate student hazarded the guess that those students with the most ability might be less buoyant than those in the middle of the distribution.

Since a search of the recent literature showed no measuring device for this trait of discouragement-buoyancy it was hoped that the new scale would prove to be a satisfactory tool for this purpose. Table 2 presents the data concerning discouragement-buoyancy for the experimental and control groups in seven areas of student life as measured by the Horrall Scale. It was found that the low group was more discouraged in these seven areas than the middle control group and that the high control group was more buoyant than the middle group. Table 2 shows the difference of the means and the critical ratios.

TABLE 2
DISCOURAGEMENT-BUOYANCY (HORRALL SCALE)

Items	Low (Experimental) M / σ_M	σ_{dist}	Middle Control M / σ_M	σ_{dist}	High Control M / σ_M	$\sigma_{dist.}$
1. Profit from college	5.34 .16	1.35	5.62 14	1.16	6.10 18	1.49
2. Success this year	3.97 23	1.90	4.60 20	1.61	5.20 21	1.71
3. Success after college	4.66 .21	1.53	5.56 12	.98	5.91 .16	1.30
4. General freshman discouragement	3.87 21	1.79	4.78 15	1.21	4.84 17	1.43
5. Grades anticipated	4.06 .16	1.35	5.06 20	1.62	6.52 21	1.71
6. Living quarters	6.80 25	2.09	7.25 .23	1.86	7.29 21	1.76
7. Faculty	5.47 19	1.60	5.74 .17	1.41	6.42 18	1.61
Total Score	34.60 69	5.74	39.18 70	5.76	42.68 .72	5.92
Total Score divided by 7	4.94		5.60		6.10	

a. Attitudes in the Separate Areas.

(1). *Means of the experimental and control groups.* Item 1, *Profit from College,* was worded at the middle point of the scale, "I get as much out of college as the average freshman." The mean of the low group on this item was 5.34 and the means of the middle and high groups were 5.62 and 6.10 respectively. The low student whose friends are presumably largely from his own college aptitude level marks himself as getting "as much out of college as the average freshman." However, the attention of the reader is called to the fact that not only does the low group succeed less well as judged by college marks, as will be seen below, but also the low students themselves feel that they are not profiting from college as much as the middle and high groups feel that they are profiting from college.

Item 2, *Success this Year,* seems related to the concept of level of aspiration. Did most of these students come to college with high hopes of success and by the middle of the second semester were they certain that they were being successful or were they becoming discouraged by failure in various aspects of college life? The middle point (5) of this item is worded, "I am as successful in everything as I thought I would be" The means for the low, middle, and high groups respectively were 3.97, 4 60, and 5.20.

Item 3, *Success after College,* may be thought to tap an area of feeling that seems remote to most college freshmen, for whom the completion of the first year at college is a milestone to be reached before giving too much consideration to what lies three years ahead, but on the other hand the subjects of the experiment checked this item as readily as any other item, suggesting that their life ahead is a real part of their thoughts. The middle point (5) is worded, "I feel that I am going to succeed as well as the average college graduate." On this item the means are 4.66, 5.56, and 5.91 for the low, middle, and high groups respectively. In other words, the low freshman feels discouraged about what he is going to amount to after college

Item 4, *General Freshman Discouragement,* was worded as objectively as possible so that if the student hesitated to give his self-judgment lower than average as was found to be the case in Huntley's experiment (8), he could indicate how he thought freshmen in general felt without committing himself. It is often true that one projects his own feelings upon the world in general and is thus able, without seeing the reason, to say or feel that because he is discouraged everyone else is. It is interesting to note that on this item for which the middle point is worded, "I think that most freshmen feel quite cheerful most of the time," the low group shows a lower mean than for any of the other seven items. It is almost as if one caught them unawares or that here they thought, "This does not relate directly to me; therefore, I can say that I think that most freshmen feel less than cheerful most of the time without implicating myself." It might be argued that the wording at the middle point (5) is toward the buoyant end of the scale but that does not alter the fact that the low group shows considerably more discouragement than the middle and high groups as evidenced by the means of 3 87, 4.78, and 4.84. If it can be assumed that the middle point is correctly worded to be midway between the two extremes it is interesting to note that the high group thinks that most freshmen are less than "quite cheerful" most of the time Is it possible that these students of exceptionally high college ability have never really worked to capacity in high school and that in a college academic situation with more students of their own ability to offer greater competition, they find themselves discouraged? Or are they, too, finding that being a freshman offers challenging adjustments to be made as Washburne found (20) when he reported that juniors have better adjustments to the college situation and to life in general than freshmen?

Item 5, *Anticipated Grades*, is the most objective of all the items in the scale Each student knows the exact letter grade which he made in each course for the first semester, and his grade index is available to him although it is not known whether every freshman looks up this grade index. Presumably only by a remarkable amount of wishful thinking can the low student expect to make much above a *B* grade (4 00 in the Purdue weighting used to calculate a scholastic index), since the grades for the first semester for the low group ranged from 1 3 to 4.6 with a mean of 3.12, with only seven students out of the 70 making 4 0 or above Also the high student knows that if he keeps up his work and does as well as he did the first semester he probably will get above a *B* grade (4 00), since the grades for the

TABLE 3A
SEMESTER GRADES

	Low (Experimental)			Middle Control			High Control		
	M	σ_M	σ_{dist}	M	σ_M	σ_{dist}	M	σ_M	σ_{dist}
First Semester	3 12	08	68	3 94	07	59	4 66	.08	64
Second Semester	3 22	08	70	3 99	08	68	4 67	09	76

TABLE 3B
COMPARISON OF STUDENTS' PREDICTIONS WITH ACTUAL GRADES

Predicted grades translated into approximate Purdue equivalents	3 53	4 03	4 76
Actual grades, Second semester	3 22	3 99	4 67
Change from prediction to actual grades	— 31	— 04	— 09

high group ranged from 3.1 to 6.3 with a mean of 4.66 and only 10 students out of the total 69 made below 4.0.

The wording of Item 5 may arouse some questions in the mind of the reader. The statement at the extreme left or low end of the continuum was, "I think that most of my grades will be below average this semester (*P, C,* or *D*)." The wording at the mid-point of the continuum was, "I think that most of my grades will be average this semester (*B*)." The wording for the extreme right or high end of the continuum was, "I think that most of my grades will be above average this semester (*A* or *H*)." After the scale had been given it appeared to the experimenter that it would have been better to omit the "*P*" and "*A*" from the statements at the extremes, but there seems no doubt that the students understood the idea of the item (which was seventh in the scale as given) and most of them checked a short distance from the middle point, conveying the idea that they would get grades either slightly higher or lower than average (*B*).

To interpret the nine-point horizontal scale in actual grade points the following was decided upon as being a logical translation, taking into account the lesser "psychological size" of steps near the center and the probably greater "psychological size" of steps near the extremes:

Scale values:	1	2	3	4	5	6	7	8	9
Grades:	1	2	3	3.5	4	4.5	5	6	6.5

Since the middle point as the scale is constructed is 5.00, the scale means of 4.06, 5.06, and 6.52 for Item 5, Anticipated Grades, for the low, middle, and high groups appear to reflect the fact that the middle group expected to make about average grades, the low group below average, and the high group above average. These predictions translated by the key above became grade indices of 3.53, 4.03, and 4.76.

The means of the second semester grades actually received by the low, middle, and high groups were 3.22, 3.99, and 4.67. The critical ratio for the difference in the actual second semester grades between the low and middle groups was 7.0 as compared to a critical ratio of 4.0 in the difference between the predicted grades of the same two groups. The difference between the middle and high groups showed a critical ratio of 5.7 for the actual second semester grades as compared to a critical ratio of 5.0 for predicted grades between the same two groups. In other words, both the actual grades and the students' prediction of their grades show a statistically reliable difference between the low, middle, and high groups.

The second semester grades (see Tables 3A and 3B) showed a mean of 3.22 for the low group as compared with a translated grade of 3.53 which they predicted for themselves on Item 5 of the Discouragement-Buoyancy Scale, with a difference of —.31. For the middle group the mean was 3.99 for the second semester grades as compared to a translated grade of 4.03 which they predicted for themselves, showing a difference of —.04. For the high group the mean for the second semester grades was 4.67 as compared to a translated grade of 4.76 which they predicted for themselves, showing a difference of —.09. This points to an interesting trend in that all groups judged that they would get slightly higher grades than they actually did (—.31, —.04, and —.09), however, it is to be noted that all three groups predicted quite accurately the grades which they received at the close of the second semester.

On the translation chart above, in the region where the means of predicted grades of the three groups lie, a step of one on the Horrall Scale equals a step of .5 in actual grades. In order to estimate the reliability of the difference between predicted grades and actual grades received for the second semester, the standard deviation of the means in the Horrall Scale has been equated to the unit of the scale of actual grades by multiplying it by .5. Using this translated standard error of the mean the estimated critical ratios of differences between predicted and actual grades are obtained (Table 4).

TABLE 4

	Low	Middle	High
Change from prediction to actual grades	—.31	—.04	—.09
Significance of the difference (critical ratio)	2.8	0.3	0.6

Someone might say that since the students in the low group predict with a fair amount of accuracy the grades they will get at the end of a semester they will not be startled and therefore should not be discouraged by the fact of low grades. However, the other items as checked in this scale indicate that they are feeling discouragement in general and that even though they do know that they are apt to perform academically less well than other students they do not like that fact. Furthermore, the estimated critical ratio presented above suggests that the students of the low group do overestimate their future standing much more drastically than either the middle or high group. This would seem to indicate that the students of the low group actually are disappointed in the grades they receive each semester, or that they feel so badly about their low grades that they never can quite face the fact that they are going to be so low.

It might be added here that Purdue University requires 90 hours of *B* grades out of the total number for graduation and most of the low group have accumulated very few of this required number in this first year, the first fourth, of the normal four-year college course.

In many observed cases these low students have said that they expected to do better on tests, or that they really knew the material covered, or, "I don't see why I didn't do better because I studied very hard." They often state that they seemed to get along in high school, and others say that they wish they had studied harder in high school, or say their failure to make better grades in college is due to a poor background in high school. These same students placed in situations suited to their mental ability would achieve satisfactions and happiness which are entirely lacking in such an academic situation as they encounter at an institution such as Purdue University. A possible solution of this problem is getting them transferred to some other institution where the kind of class work requires less native intelligence for achieving success in the academic situation and where the total student group is placed lower in the scale of intelligence. Another solution is, of course, to help the student get out of college altogether and into congenial paid work. The mental hygiene penalties of continued failure for honest, strenuous industry seem too obvious to require extended comment although they appear to be totally ignored in the administration of most colleges.

Item 6, *Living Quarters*, shows the least difference between the three groups and the highest buoyancy of the seven items. This perhaps reflects the fact that living quarters are exceptionally good for freshmen at Purdue University and in many cases are better than the student has encountered previously. An inspection of the information cards indicating where the students lived showed there was very little difference in the three groups as to type of living quarters. It is interesting to note, however, that although the low group lives in almost identically the same type of living quarters, they yet feel less buoyant about the place they live in than do the middle and high groups. Many of the freshmen of all three levels live in the residence halls. This residence fact may go to prove the point that one cannot escape from one's inner feelings no matter how ideal the surroundings.

Item 7, *Attitude of the Faculty toward Students*, was intended to test whether the low group feels that the faculty is discriminating against them since many of them are encountering difficulty in the academic situation. These students may have hesitated to express their real feelings toward the faculty since the mean of the low group was 5.47 and the wording of the item at the midpoint (5) on the scale is, "Most faculty members seem to me usually about like most citizens, fair on the whole and having medium interest in students. They have some, but not complete, understanding of students." There is also the hopeful possibility that faculty members do give a good account of themselves, which fact is still evident to the students of the low group in spite of their own troubles. The middle and high groups had means of 5.74 and 6.42 on this item respectively, showing that in any case they feel more confident about faculty attitudes toward them than do those in the low group.

(2). *Significance of differences of means.* The significance of the differences of the means of discouragement-buoyancy as measured on the Horrall Scale between the low and middle groups, between the middle and high groups, and between the low and high groups are presented in Table 5 as critical ratios (the difference between the means divided by the standard error of the difference). It will be noted that Item 3, *Success after College,* shows a critical ratio of 4.1 between the low and middle groups; Item 4,

TABLE 5
DISCOURAGEMENT-BUOYANCY RELATED TO INTELLIGENCE—SIGNIFICANCE OF DIFFERENCES ON THE HORRALL SCALE

Items	*M* minus *L* Diff σ_{diff}	*CR*	*H* minus *M* Diff σ_{diff}	*CR*	*H* minus *L* Diff σ_{diff}	*CR*
1. Profit from college	28		.48		.76	
	210	1.3	23	2.1	24	3.2
2. Success this year	.63		60		1.23	
	30	2.1	29	2.1	31	4.0
3. Success after college	90		.35		1.25	
	22	4.1	.20	1.8	24	5.2
4. General freshman discouragement	91		.06		97	
	26	3.5	23	0.3	27	3.6
5 Grades anticipated	1.00		1.46		2.46	
	26	3.8	.29	5.0	26	9.5
6 Living quarters	45		04		49	
	34	1.3	31	0.1	33	1.5
7 Faculty	27		68		95	
	.25	1.1	.25	2.7	26	3.7
Total Score	4.58		3.50		8.08	
	98	4.7	1.00	3.5	1.00	8.1

L — Low
M — Middle.
H — High

General Freshman Discouragement, shows a critical ratio of 3.5, and Item 5, *Grades Anticipated,* shows a critical ratio of 3.8 between the low and middle groups. There is a critical ratio of 2.1 on both Item 1, *Profit from College,* and Item 2, *Success this Year,* between the middle and high groups, and Item 7, *Faculty Attitude,* shows a critical ratio of 2.7 between the middle and high groups. Item 5, *Grades Anticipated,* shows a critical ratio of 5.0 between the middle and high groups.

The differences between the low and high groups are the most striking, which shows that there is a very significant difference between the low and high groups as to discouragement and buoyancy in the college situation. The differences are statistically significant between the low and the high groups for six items out of seven on the Horrall Scale, ranging from 3.2 to 9.5. Item 6, *Living Quarters,* shows considerable buoyancy for all three groups, with a critical ratio of 1.5 for the difference between the low and high groups

b. General attitudes of discouragement and buoyancy The total scores on the Discouragement-Buoyancy Scale appear to give the answer to the main question of the study, "Are students of the lowest ranks in intelligence disheartened and discouraged by their college experience?" Means of 34.60, 39.18, and 42.68 were obtained for the low, middle, and high groups (average scores per item of 4.94, 5.40, and 6.10 for the low, middle, and high groups respectively). As shown in Table 5, the differences of the means for three groups on Total Score are statistically significant throughout. The critical ratio is 4.7 for the difference between the low and middle groups, 3.5 for the difference between the middle and high groups, and 8.1 for the difference between the low and high groups. It appears safe to conclude that if the Horrall Scale is measuring discouragement-buoyancy, the low group in college aptitude is distinctly more discouraged in the college situation than the middle group, and the high group is even more comfortable than the middle group. In comparing the low and high groups, one finds that the difference in discomfort and comfort or discouragement and buoyancy is very great.

As has been said, the main question of the experiment appears to be answered by these findings on the Horrall Scale. Students in the low group (at or below the 10th percentile in the *ACE* Psychological Examination) apparently are markedly discouraged and depressed as compared to those in the middle group, for whom college work is probably especially adjusted as to difficulty, and as compared to those in the top group for whom the work is comparatively easy. It appears likely, furthermore, that all factors of group living operate in the same direction as do the academic factors, namely, to discourage those lowest in ability who cannot understand what their fellow students expect of them This baffling experience of failure to comprehend what is going on in the classroom and in other fields of college endeavor must be cumulative in that each day's experience must add to the discouragement and disillusionment of the student as to his ability to cope with the college situation and to find later a satisfactory vocational and social niche out in the world.

If a critical ratio of 3 00 is generally accepted as being statistically significant, then ratios of 4.7, 3 5, and 8 1 on a Total Score for a test of a psychological nature would appear to be highly significant and should provoke serious consideration of the problem of subjecting such numbers of students with low college ability to the discouragement of the college situation as indicated on the Discouragement-Buoyancy Scale and as suggested by general observation. From the mental hygiene standpoint, one must experience satisfaction and success at least a substantial part of the time or mental health is bound to be lessened, making it often difficult later on to reestablish faith in one's own ability and worthwhileness.

c. Correlation between discouragement-buoyancy and intelligence The coefficient of correlation between discouragement-buoyancy as measured by the College Experience Scale and intelligence as measured by the *ACE* Psychological Examination could not be computed by the usual Pearson product-moment procedure since the distribution of intelligence in this study represents a mutilation of the normal curve in that a sample was taken from the low part of the distribution and samples from the middle and high parts matched with it The correlation technique suggested by Peters and Van Voorhis (14, pages 399-402) to use with quantitative variates of unequally spaced intervals did, however, seem available for the data of this study.

The discouragement-buoyancy scores were arranged along the vertical axis and the distance from the mean of the distribution figured in standard deviation values for the mean of the steps (using the percentage of the total number in each step to locate the mean sigma value of the step).

The intelligence scores were placed on the horizontal axis and the actual percentile means used instead of percentages to locate the mean sigma value of the step. This appeared to be a more accurate way to locate the sigma distance of the step from the total mean because it was known that the assumption used to locate steps on the other axis did not apply (namely, that the measures all together constituted a full normal curve of distribution) Had each intelligence test score been read back separately from its percentile value to its sigma value on a normal curve of distribution and the mean of the step calculated from these individual sigma values, the mean of the step might have had a slightly different sigma value, but it was assumed that the difference would not be great and that the added labor of the other procedure was not necessary.

The coefficient of correlation was then computed as a Pearson r for any correlation table. It was then corrected on the vertical axis for broad categories inasmuch as there were only 10 steps used in grouping the discouragement-buoyancy scores, and on the horizontal axis for rectangular distribution since the three steps were made up of practically the same numbers instead of being the form of a normal distribution.

The r as computed and corrected by the above procedure was $+.52$ with a standard error of 05 which shows that there is a definite positive relationship between intelligence and discouragement as measured by the College Experience Scale. By multiplying the standard error of the r by three and subtracting from $+.52$ we have $+.37$, or multiplying by six, $+.22$, which indicates that the true correlation between discouragement-buoyancy and intelligence is real, in other words, larger than zero.

Professor I. W Burr, of the Mathematics Department of Purdue University, evolved a new formula for a multi-serial r to be used with a mutilated distribution such as the low, middle, and high samples of the present study. This formula is a generalization of that in Peters and Van Voorhis (14) for biserial r with wide-spread classes. He himself utilized the data herein set forth for intelligence and total scores on the College Experience Scale and calculated the r. This method yields a correlation coefficient of $+ 364$ between discouragement-buoyancy and intelligence. This is essentially an estimate of the correlation one would get if all cases were chosen rather than the three groups.

The standard error formula has not been worked out for the new formula for multi-serial correlation. However, it would appear that an upper limit for the standard error of the r would be $1 — 364^2$ divided by the square root of $N—1$ or 206 which is 06 (Probably it is a good deal less than this.) Since $+.364$ is over $6\sigma_r$ from zero there seems no doubt but that the true correlation is positive.

The Burr formula as applied happens to follow one of the fundamental assumptions of this study in that it does classify cases not by their "absolute intelligence" but by the percentile location of the cases within their *own school.* The quantitative variates of unequally spaced intervals formula as applied by the writer gives the cases their "absolute" intelligence test percentiles as of the university as a whole.

In general the multi-serial r method of calculating the correlation tends to verify the unequally spaced intervals method of calculating the correlation in that both are real correlations and both positive. What the discrepancy in size of correlations estimated by the two methods may mean is not at present clear. At all events, it is apparent that there is a real, positive correlation between buoyancy and intelligence in the college situation

d. Reliability and validity. It seemed impossible to establish the reliability of the New Scale on Discouragement-Buoyancy by regiving the test, because it appeared likely that having taken the test once the subjects might set up defensive reactions such that they would have a certain need to check the scale differently the second time Since that avenue was closed, it was decided to explore a split-half correlation although that measure is probably logically more a test of consistency than of reliability. However, a split-half correlation is presented for what it is worth since it is a technique which is frequently utilized

A problem encountered was which items to put in each half inasmuch as there were seven items rather than an even number. Furthermore, it seemed that the last two items were of a slightly different sort, exploring areas which might show kinds of discouragement a little apart from the kind covered in the first five items. It was decided consequently to place Items 1, 3, and 5 together and Items 2 and 4 together and to add Item 6 to the first group and Item 7 to the second group thus making the "halves" Items 1, 3, 5, and 6 against Items 2, 4, and 7.

After the distributions were made for each of the three intelligence levels, it was judged by inspection that there was not a linear relationship between the two variables but a curvilinear or some other relationship. Therefore, the Pearson product-moment coefficient of correlation did not seem to be the correct one to use. The eta and epsilon types of relationship were then computed.

The separate epsilon squares did not reach the 5 per cent point of significance. Epsilon square was —007 for the low group, +.095 for the middle group, and + 101 for the high group Since epsilon is independent of the form of the distribution and since a restricted range always lowers the correlation, it seemed permissible statistically to throw all three distributions together This gave an epsilon square of +.2131 which has less than a one per cent likelihood of being a chance correlation (14). With an N (*number*) of 207 and k (number of columns) of 17, an epsilon square at the one per cent level of chance would be .0794. The correlation between "halves" is, then, real and not a chance relationship.

Epsilon for the split-half procedure is +.46, a medium, positive correlation. Even though the split-half technique appears to be a test of consistency instead of reliability, still whatever it measures we have here evidence that the two halves of the scale appear to be measuring in large part the same general human trait. There may be an advantage in having items that do not yield an epsilon higher than +.50 for split-halves thus insuring a wider sampling of different manifestations of the "same" trait.

First, by inspection of the content of items in the Discouragement-Buoyancy Scale, second, by the foregoing evidence of fair consistency of parts of the scale with other parts, and third, since it seems impossible to go back of an individual statement of how a person believes he feels about something, we conclude that we have as much evidence of validity as could probably be secured on a psychological test of this nature. It is believed that the seven items in the final College Experience Scale are measuring what is usually meant by discouragement-buoyancy

e. Discarded items—Horrall Scale. In the discarded items of the trial discouragement-buoyancy scale, it will be noted in Table 6 that the means did not run consistently from low to middle to high as did those of

TABLE 6
DISCARDED ITEMS—HORRALL SCALE

Items	Low (Experimental)		Middle Control		High Control	
	M σ_M	σ_{dist}	M σ_M	$\sigma_{dist.}$	M σ_M	$\sigma_{dist.}$
1 Intensity of study (1)	4.81 .18	1.51	5.09 .16	1.31	4.65 .19	1.55
2. Morals in college (6)	4.97 .23	1.92	4.69 .18	1.44	4.45 .18	1.49
3 Making friends (8)	5.66 .20	1.65	5.47 .19	1.55	5.51 .19	1.62
4. Warmth of friendships (9)	5.74 .16	1.30	5.54 .15	1.20	5.59 .14	1.17
5. Personal attractiveness (11)	5.21 .16	1.34	5.26 .17	1.38	5.12 .15	1.22
Total score (calculated from means above)	26.39		26.05		25.32	
Total score divided by 5	5.28		5.21		5.06	

the seven items presented in Table 2. These items (Intensity of Study, Morals in College, Making Friends, Warmth of Friendships, and Personal Attractiveness) appear to be measuring something other than the trait or traits measured by the seven selected items, all of whose means progress in the same direction. It appeared likely that those five items do not measure discouragement-buoyancy of the same general sort that the seven selected items do and the five were therefore discarded from the final Horrall College Experience Scale.

As is usual with a self-checking instrument, the question of validity of the measuring instrument is a baffling one, and perhaps all that can be logically used as a criterion is the fact that whatever the subject says he feels about the content of the instrument is what he does feel in that area. One might refer again to the statement of Pintner and Forlano (15) that, "There is no generally acceptable method for the validation of a psychological test."

By inspection of the total score (calculated from the means of the five discarded items) in Table 6, it will be seen that there is very little difference in the means of the total scores of the groups, namely, 34 between low and middle, and .73 between middle and high, as compared to the differences in the total score of the seven items in the final scale (see Table 2) where the difference is 4.58 between the low and middle groups and 3.50 between the middle and high groups The discarded items showed differences in average score per item of .08 and .15 between the low and middle, and middle and high as contrasted with the final Discouragement-Buoyancy Scale differences in average score per item of 66 and .50 It did not seem worthwhile to calculate critical ratios for these differences since they are almost certain to be well within the range of chance differences.

In the item, *Intensity of Study,* it is to be noted that the low group think that they study more than most students since the mid-point (5) is worded, "I study about as much as most students" and the mean of the low group is 4.81 (The greatest intensity of study was stated at the low or left end of the continuum). However, the high group had a mean of 4.65 for this item when many things point to the fact that these students do comprehend the subject matter much more quickly and easily than do those of the low and middle groups and do not study as assiduously as the low group. It is an interesting question as to why the two groups that appear by inspection to be studying so much more and so much less as the low and the high groups do still mark themselves almost equal. Possibly the high group has never met work of such difficulty that they had to study at all, making a little work seem like a great deal, whereas the low group all through elementary and high school must have worked industriously to get any academic results at all.

The item, *Morals in College,* presents a trend which indeed might well be given further consideration. As shown in Table 6, the high group shows greatest concern over morals in college, while the middle group is in the middle, with the low group showing least discouragement in this area. The differences in means are not great but suggest greater significance when viewed in the light of the means of the Mooney Problem Check List where again the high group has the most problems in the area of Morals and Religion On the Mooney List, also, the low group shows the fewest problems in this field, and the mean for the middle group is between the high and the low.

Does this indicate that those higher in intelligence notice and think about the discrepancies in the field of morals between the world at large and their previous home-town patterns? Does it mean that they think more profoundly about social-moral problems which do not trouble those of lower intelligence who do not think very much about them? Does it mean that those of the highest college ability explore wider areas of relationships and at the same time do not receive any more help in evaluating their new experiences than these simpler and possibly more conforming persons who perhaps remain in more familiar grooves? Or have those of *higher intelligence thought through their stand on moral issues apart from* their parents' and home-town patterns and are of sufficient stamina to stand by these opinions and also not "follow the herd" in college and yet feel conflict over these ideas? The latter idea was brought out in several sophomore Elementary Psychology class discussions during the college year when the freshmen of the experiment would have become sophomores.

As to the items on *Making Friends and Warmth of Friendships,* it is known that people of various native intelligences tend to make friends near their own level Perhaps in college there are enough students available at each level for everyone to have some friends, the low group feeling as close to their friends as do the middle and high groups within their levels. This fact is suggested by the means of the two items inasmuch as there are very slight differences between the mean scores of the three levels Perhaps also it would be intolerable to suppose that one could not make friends and that one's friends did not care for one, even though various experiments have indicated that when ratings are made by others rather than the person himself those of higher intelligence are better liked by the experimental population'

The item on Personal Attractiveness also shows but slight differences between the three levels. The experimenter wonders if the students were on the defensive and if the results would have been different had the items been worded similarly to the item on general freshman discouragement (Item 4 in Final Scale) such as for the mid-point, "I think that most freshmen are quite attractive." Here again reference might be made to Huntley's findings (8) in that strivings for self-esteem influenced self-judgment if the subject recognized that he was judging himself, in that he always marked himself above average. The subjects of all three groups of the present study marked themselves above average or mid-point (5) on the scale which was worded, "I am about as attractive as most college freshmen".

3. *Influence of Factors Other Than Intelligence on Discouragement-Buoyancy*

Whether one is organized or unorganized, whether one is supported by one's family or is working one's way through college, whether one is a man or a woman appears to have nothing to do with how discouraged or buoyant one is. (See Table 7.) In striking contrast is the fact presented above that one's position in the scale of intelligence in the group with which one goes to college is apparently the powerful factor in causing one to be discouraged or buoyant.

Because of the way in which the experiment was set up, it is possible to summarize the scores for all organized students and similarly for all unorganized students with all other factors in the experiment, including intelligence, equated. In the same way, totals can be calculated for all family-supported students and for those earning money to put themselves through college.

The situation with respect to summarizing for sex is a little different inasmuch as all but seven of the women in the experiment were concentrated in one school which had in it no men students Consequently, in the summaries for men and women the factor "academic school" is not equated although all other factors are equated.

a. Organized as compared to unorganized The mean score for the organized students (all levels together) was 38.30, and for unorganized students, 38.96, giving a difference of .66 in favor of the unorganized as to buoyancy The critical ratio of this difference is .63 (see Table 7), apparently a purely chance difference.

b. Family-supported as compared to earning. The mean score (all

TABLE 7

DISCOURAGEMENT-BUOYANCY (HORRALL SCALE)—TOTAL SCORE GROUPED BY FACTORS UTILIZED IN MATCHING SUBJECTS

	Low (Experimental)		Middle Control		High Control		All Levels		Diff.	
	M		*M*		*M*		*M*			
Factors	σ_M	$\sigma_{dist.}$	σ_M	σ_{dist}	σ_M	σ_{dist}	σ_M	$\sigma_{dist.}$	σ_{diff}	*CR*
Organized	35.40		38.70		41.36		38.30			
	1.10	4 80	1.66	6 22	1 65	6 58	.89	6.38		
									.66	
									1.05	63
Unorganized	34 28		39 30		43.12		38 96			
	.86	6 04	.78	5 62	78	5.60	.55	6 78		
Family supported	33 68		39 04		42 68		38.21			
	.75	5 38	.78	5.58	.91	6 00	.55	6.74		
									.12	2.12
									1 00	
Earning	37.48		39.62		42 68		40 32			
	1.46	5 84	1 62	6.28	1 18	5 76	84	6 32		
Men							38.42			
							.58	6.94		
									1.18	
									.96	1.2
Women							39.60			
							.76	6 04		

levels together) for the family-supported students was 38 21 and for students earning all or part of their expenses 40.32, giving a difference of 2.12 (see Table 7) The critical ratio of this difference is 2 12 which is much more significant statistically than the difference between the organized and unorganized students. It happens that the majority of students earning money are from one school and in many cases these students come from rural communities where they have been earning money for several years. Perhaps because of their past experience, they feel no discouragement at having to help support themselves in college. It should be noted further that the college in which most of these self-supporting students are enrolled is one in which self-support is the usual pattern. Perhaps also, the family-supported students in many cases feel more dependence upon their families and have undergone less psychological weaning Furthermore, the schools are not actually equated in the comparison of family-supported with self-supported students

In this study in the school in question, 38 subjects were self-supporting or partially so and 26 were family-supported. Outside the school in question, there were only 20 self-supporting students or those earning money out of the other three *school* groups The mean discouragement-buoyancy score of the school in question (all levels) was 39.80 The mean for all the other school groups together was 38.34 There is here a difference of 1 46 in means, with a standard error of the difference of .82, giving a critical ratio of 1 8. This suggests that the element of self-support or partial self-support has not been fully isolated in this summary and that what may be being observed here is the greater buoyancy of one school rather than self-support as such

The mean intelligence score of the present sample of the school in question was 36.29. The mean for all the other school groups together was 50.24. The fact that the "absolute" intelligence of this school group was lower than that of all the rest of the schools in the experiment suggests that the academic work of that school is easier than the work of other schools. This in turn seems to indicate that it may be success in academic work rather than pleasure in self-support that may account for the higher buoyancy of self-supporting students in this study.

Washburne (20) studied 119 freshmen and 119 junior women at Syracuse University for whom the intelligence, home conditions, college activities and affiliations were ascertained. Among his findings he reported that, "When the degree and number of differences in total social adjustment are considered, the girls who earn part of their way through college are the most superior of all the compared groups in nearly all phases of social and emotional adjustment. Whether work causes the social adjustment, or the superior adjustment causes the girls to be willing and able to work their way through college, or whether the causation is circular is a matter of speculation." Hale (6) reports almost opposite findings in comparing earning with family-supported women students at Purdue University in 1934. She found that employed women students as rated on the Bernreuter Personality Inventory were less well-balanced emotionally, less gregarious, less sociable, and less dominant than women students who were not gainfully employed.

c Men as compared to women. The mean score for the men students was 38.42 and for the women students, 39.60, giving a difference of 1.18. The critical ratio for this difference is 1.2 (see Table 7) Women students here appear to be slightly more buoyant than men students, but the difference with this *N* is well within chance.

4. *Optimism-Pessimism* (Chant-Myers)

As was pointed out above in the discussion of tests used in the study, although the Chant-Myers Scale seemed likely to be too gross a measurement, discriminating only great extremes, it offered a possibility of exploration in the field of discouragement-buoyancy. Chant and Myers (2) stated that the degree of differentiation at the upper or optimistic end of the scale does not seem adequate for undergraduate subjects. This agrees with the findings of the present study as the means of 7.24, 7.33, and 7.17 for the low, middle, and high groups respectively indicate (see Table 8A). The critical ratio of the difference between the low and middle group is 5; between the middle and high groups, 9; and between the low and high groups, .4 These differences are not large enough to be significant However, the results show that all three groups are normal as compared with the group of mental hospital patients used by Chant and Myers in the construction of the scale who showed both extreme depression and extreme elation.

The mean score for the total number in the present study was 7.28, as compared to the score of 7.56 for Purdue University undergraduates reported by Whistler and Remmers (21) The latter study was made in April, 1937, and the subjects were above the freshman year in college which may account for the lower mean of the group of the present study This may be reflecting the fact which Washburne (20) pointed out in his study comparing freshmen to juniors as to adjustment to the college situation and to life in general, namely, that a freshman has a harder time There might be a possibility, of course, that the date of the present study,

TABLE 8A
PESSIMISM-OPTIMISM AS MEASURED BY CHANT-MYERS SCALE

Low (Exerimental)		Middle Control		High Control	
M σ_M	σ_{dist}	*M* σ_M	σ_{dist}	*M* σ_M	σ_{dist}
7.24		7 33		7 17	
12	1 00	10	81	14	1 19

TABLE 8B
SIGNIFICANCE OF DIFFERENCES ON CHANT-MYERS SCALE

M minus *L*		*H* minus *M*		*H* minus *L*	
Diff σ_{diff}	*CR*	Diff σ_{diff}	*CR*	Diff σ_{diff}	*CR*
0 09		0 16		0 07	
.16	0 5	.17	0 9	18	0 4

L — Low.
M — Middle
H — High

the spring following Pearl Harbor, might affect undergraduate buoyancy.

The average mean score of 7.28 for the freshmen of the present study is slightly higher than the mean score of 7 10 for 300 undergraduates at Toronto University and is clearly higher than the mean score of 6.10 for 117 employed men as reported by Chant and Myers (2).

Our results do not agree with the findings of Whistler and Remmers (20) that there was a low positive correlation between psychological percentiles and optimism as measured by the Chant-Myers Scale The mean of the low group (7 24) is slightly lower than the mean for the middle group (7 33), but the high group is not correspondingly higher. The experimenter thinks that perhaps the test was given at a disadvantageous position in the battery since it was the final scale to be marked and the subjects may have become so weary as not to have given the test as careful a reading as the preceding tests in the battery. How this would affect the score is, of course, not known. Our conclusions are in agreement with those of the authors of the scale in that the measuring device does not differentiate closely enough toward the upper or optimistic end of the scale, and depending on how it is to be used it should perhaps be revised with that defect in mind as the authors have suggested.

According to the findings of the present study, the Horrall Scale apparently does measure discouragement-buoyancy more finely at the freshman level, whereas the Chant-Myers differentiates between the extremes of pessimism and optimism.

5. *College Problems—Mooney Check List*

As was pointed out above in the discussion of the battery tests used in the study, the Mooney Problem Check List presents a large number of items (330) which are classified into 11 general areas of college experience. Many of the items counterbalance others in the same area; consequently, the list as organized at present does not lend itself well to statistical analysis. However, the items do present an interesting array of problems of college students and it was decided to include the Check List in the battery of tests for this reason

The experimenter wondered whether the students of the lowest reading ability could comprehend all of the items. She had tried out the Check List on a few students of slightly higher ability than the experimental group and found that they did not understand the meanings of the words used in several of the items. After compiling the results from the Reading Test as given below, and finding that the reading ability of the low group was as low as the sixth grade (elementary school) for some students, with the mean at about ninth grade level and with 33 out of the total 70, or nearly one-half, with a reading ability less than the ninth grade level, one wondered how many of the statements of problems could really be read by a student of ninth grade ability or below It is not clear how reading comprehension would affect the Mooney score. It is possible that the poor readers have checked fewer problems than they would have if they could have comprehended what they read. If this should be true, then the discouragement score registered on Mooney by the low group in this study is perhaps over-conservative

The means of the number of problems checked by the low, middle and high groups are presented in Table 9 The areas which show the largest number of problems checked by the low group, the next largest number by the middle group, and the fewest by the high group are: (5) Personal-Psychological Relations, 4.34, 3.50, and 3.04; (9) Adjustment to College Work, 7 74, 5 00 and 2 52, and (11) Curriculum and Teaching Procedures, 3.63, 3.44, and 3.33

The area, (5) *Personal-Psychological Relations,* includes problems such as "Moodiness, having the 'blues'," "Not doing anything well," "Too easily discouraged," "Lacking self-confidence," and "Afraid of making mistakes" very often checked by the low group.

The area, (9) *Adjustment to College Work,* presents an alarming picture for the low group For instance, one student in the low group chosen by

TABLE 9
MOONEY PROBLEM CHECK LIST—COLLEGE FORM

	Low (Experimental)		Middle Control		High Control	
	M σ_M	σ_{dist}	M σ_M	σ_{dist}	M σ_M	σ_{dist}
(1) Health and physical dev	2 97 45	3 76	2 68 24	1 94	2 68 .28	2.30
(2) Finances, liv cond, employ	1 63 .34	2.85	1 76 34	2 79	1.91 .27	2.20
(3) Soc. and recr. activities	3 99 42	3 47	4 63 .43	3 53	4 35 .39	3 21
(4) Soc and psych relations	2 01 .30	2 46	2 15 33	2 70	2 85 .35	2.85
(5) Personal-psych. relations	4 34 49	4.10	3 50 39	3 22	3.04 .31	2.58
(6) Courtship, sex, marriage	2 53 32	2 66	2.88 32	2 62	2 54 32	2 61
(7) Home and family	1.61 .29	2.41	1 31 18	1 48	1 38 .24	1.95
(8) Morals and religion	1 24 24	1.97	1 52 24	1 95	1 93 .25	2 09
(9) Adjust to college work	7.74 .63	5 22	5 00 50	4 07	2 52 29	2 40
(10) The future voca. and educ	3.13 .36	3 01	3.25 38	3 15	2 77 .30	2.48
(11) Curriculum and *teach proced*	3.63 .43	3 60	3 44 38	3.08	3.33 .40	3 28
Total number underlined	33 36 2.96	24 54	29.58 2 29	18 78	26 76 1 98	16.32
Total number circled	11.73 1 31	10 86	10.86 97	7 92	10 08 1.07	8 79
Percentage of underlined which were circled	34 15 2 80	23 30	30 45 2 39	19.75	29.35 2 34	19 30

"Not smart enough in scholastic ways"
"Unable to express myself in words"
"Worrying about examinations"
"Not getting studies done on time"
"Unable to concentrate well"
"Afraid to speak up in class discussions"
"Vocabulary too limited"
"Weak in writing"
"Weak in spelling or grammar"
"Slow in reading"

This is a total of 17 problems checked out of a possible 30 problems in this area, all 17 of which the student called serious problems of his He had checked a total of 25 on the entire scale. If this student was willing to admit on paper that he had this number of serious problems in the area of Adjustment to College Work, one can well imagine the great amount of discouragement and defeat that he was feeling. This is not an unusual case but is, rather, typical of a large number of students in the low group.

In the area of Curriculum and Teaching Procedures (11), the problem worded as "Inadequate high-school training" was often checked. In certain psychological clinic work which the writer has done with students of low college ability, this point was often brought up, namely they frequently said that they had had a poor high-school background and wished they had "studied in high school." Here again it might be suggested that a wise system of vocational guidance in high school would have guided these who had low college aptitude, little ability to do abstract thinking, into lines of endeavor in which they could have been successful, thereby producing the mental well-being which constitutes so much of the satisfaction and happiness of any individual

In considering the total number of items underlined (Table 9), one finds that the mean number of problems for the low group was 33.36, for the middle group 29.58, and for the high group 26.76. The total number of problems circled or those problems considered serious was 11 73 for the low group, 10.86 for the middle group, and 10.18 for the high group.

The gloominess of the student may be indicated by the percentage of his problems which he feels are serious problems. The percentage of underlined items which were circled showed again that the low group had the highest percentage, 34.15, the middle group next, 30.45, and the high group the lowest percentage, 29.35

These three sets of figures show that the low group indicated the largest number of problems (underlined), the largest number of serious problems (circled), and the largest percentage of serious problems compared to total problems (total number circled divided by total number underlined), in spite of the fact that they had by far the lowest reading ability as shown by the Reading Test scores given in a later table. One can but raise the question as to how many more problems the students of the low group would have checked had their reading ability been equal to that of the middle or high group.

Here again in three areas of the Mooney Problem Check List (Personal-Psychological Relations, Adjustment to College Work, Curriculum and Teaching Procedures) in the Total Number Underlined, in Total Number Circled, and in Percentage of Underlined which were Circled, we find the low group with the largest number of problems, the middle group with the next largest number, and the high group with the smallest number These findings are in absolute agreement with the findings on discouragement-buoyancy as measured on the Horrall College Experience Scale in which the low group showed a discouragement which was statistically significant when compared with the middle group. The high group showed a buoyancy which was statistically significant when compared with the middle group, and strikingly significant when compared with the low group The findings on the Mooney Problem Check List therefore reinforce the conclusion reached in connection with the discouragement-buoyancy scale findings, namely, that the low group in college aptitude is subjected to a tremendous amount of pressure in the college situation causing a discouragement which should no longer be overlooked, the realization of which must certainly constitute a moral responsibility resting upon a university to remedy the situation in the best possible way.

As was stated previously, there is a mixture of items of opposite meaning in each of the Mooney categories. Consequently, a detailed statistical analysis of the Mooney scores does not seem justified. The author hopes at a later time to arrange the items in new categories and examine these new categories statistically Meanwhile, questions of significance of differences were investigated only on the three types of total scores and on three individual categories (see Table 10). The author also plans to present later an item analysis of the 330 items to show which problems are most prevalent at Purdue University and which are least prevalent.

Table 10 shows the differences of the means of the three areas in which the low group shows the greatest discouragement (by checking the greatest number of problems), the middle group the next highest buoyancy, and

TABLE 10
DIFFERENCES OF MEANS AND CRITICAL RATIOS IN SEVERAL MOONEY PROBLEM CHECK LIST SCORES

	L minus *M*		*M* minus *H*		*L* minus *H*	
	Diff. $\sigma_{diff.}$	*CR*	Diff $\sigma_{diff.}$	*CR*	Diff. $\sigma_{diff.}$	*CR*
(5) Personal-psych.	.84		.46		1.30	
relations	.63	1.3	.50	.92	.58	2.2
(9) Adjustment to	2.74		2.48		5.22	
college work	.80	3.4	.58	4.3	.69	7.6
(11) Curriculum and	.19		.11		.30	
teach proced.	.57	0.3	.55	0.2	.59	0.5
Total number	3.88		2.72		6.60	
underlined	3.74	1.0	2.86	0.9	3.55	1.9
Total number	.87		.78		1.65	
circled	1.63	0.5	1.44	0.5	1.69	0.9
Percentage of underlined which	3.70		1.10		4.80	
were circled	3.68	1.0	3.34	0.3	3.65	1.3

L — Low.
M — Middle.
H — High.

the high group the highest buoyancy. As will be noted, the critical ratio for the difference between the low and the high group in Personal-Psychological Relations is 2.2, which approaches significance. The differences between the means for Adjustment to College Work are significant statistically in that the critical ratio for the difference between the low and the middle group is 3.4, between the middle and high group 4.3, and between the low and high group 7.6. These findings in this area agree very closely with the critical ratios for the differences in the means for Anticipated Grades in the Horrall Scale, and reinforce the conclusion that the low group is facing tremendous discouragement in this field

As will be seen in Table 10 the three total scores do not yield statistically significant differences, but the fact that they progress in the same direction, namely from low to middle to high, seems to have some significance.

It is interesting to note how closely the findings on the Mooney Problem Check List of the freshmen at Purdue University parallel those of the freshmen women at Ohio State University. Mooney (12) reports the average number of problems marked as 29.8 with a range from 3 to 106 for a sample of 171 freshmen women living in the dormitories at Ohio State University. The above sample of 171 women was made up of about one-third representing well-adjusted individuals, one-third representing poorly adjusted individuals, and one-third representing cases in the middle area as to adjustment, according to the opinion of graduate resident counselors. The average number of problems checked by the 207 freshmen in the present study was 29.9 with a range from 0 to 121.

Table 11 shows the average number of problems checked by the Ohio State University freshmen women in each of the 11 areas of the Problem Check List as compared with the average numbers checked by the 207 freshmen at Purdue University who were subjects in the present study. It is surprising that the average number of problems in each area parallel each other so closely for the freshmen in the neighboring universities. These figures offer the executives of such educational institutions information concerning the types of problems which the students are encountering in their first year of college, problems with which they presumably need immediate help.

TABLE 11
COMPARISON OF AVERAGE NUMBER OF PROBLEMS CHECKED ON MOONEY PROBLEM CHECK LIST BY 171 OHIO STATE UNIVERSITY FRESHMEN WOMEN AND 207 PURDUE UNIVERSITY FRESHMEN

Area	Ohio State University	Purdue University
Adjustment to College Work	5.4	5.1
Personal-Psychological Relations	4.2	3.6
Social and Recreational Activities	3.3	4.3
Health and Physical Development	3.1	2.8
The Future Vocational and Educat	2.8	3.1
Curriculum and Teaching Procedures	2.8	3.5
Social Psychological Relations	2.1	2.3
Courtship, Sex, and Marriage	1.9	2.6
Finances, Living Cond. and Employ.	1.5	1.8
Morals and Religion	1.5	1.5
Home and Family	1.3	1.4

6. *Ascendance-Submission (Allport Reaction Study)*

It was pointed out in the discussion of tests used in the battery that it seemed likely that the Allport Ascendance-Submission Reaction Study is a measurement of more thoroughly established personality traits and probably would not respond quickly to current conditions of college success and failure. Since it seemed of interest nevertheless to determine how ascendant or submissive the subjects of this study were, it was decided to include the test in the battery used

Table 12A presents the mean scores on the *A-S* Reaction Study, namely,

TABLE 12A
ASCENDANCE-SUBMISSION AS MEASURED BY THE ALLPORT *A-S* REACTION STUDY

Low (Experimental)		Middle Control		High Control	
M		M		M	
σ_M	σ_{dist}	σ_M	σ_{dist}	σ_M	σ_{dist}
—3.0		—6 05		+.30	
2.08	17.30	2.12	17.25	2.33	19 25

TABLE 12B
SIGNIFICANCE OF DIFFERENCES ON *A-S* STUDY

L minus *M*		*H* minus *M*		*H* minus *L*	
Diff.		Diff		Diff.	
σ_{diff}	*CR*	σ_{diff}	*CR*	σ_{diff}	*CR*
3 05		6.35		3 30	
2.97	1.0	3.15	2.0	3 12	1.1

L — Low.
M — Middle.
H — High.

—3.0, —6 05, and +.30 for the low, middle, and high groups respectively. Table 12B shows the significance of differences for the three groups in terms of critical ratios. There was a critical ratio of 1.0 for the difference between the low and middle group; a critical ratio of 2.0 for the difference between the middle and high groups, and a critical ratio of 1.1 for the difference between the low and the high groups. The critical ratio for the difference between the middle and the high groups is the only one of the three that might be considered to even approach statistical significance.

It is somewhat surprising to note that the middle control group shows the most submission as measured by this Reaction Study, the low group is not quite as submissive, and the high group registers a slightly positive or ascendant tendency However, as indicated in the Manual of Directions, Scoring Values, and Norms, the average on the form for men ranges from +4 to —4 and on the form for women from +10 to 0.

The results of the *A-S* Reaction Test as given above seem to indicate that there is no correlation between ascendance-submission and intelligence This is in absolute agreement with the findings of Ruggles and Allport (17) in that various unpublished studies agree that there is a zero or negligible relationship between ascendance-submission and intelligence as measured by tests. Bender (1) also found no significant correlation between intelligence scores of 192 sophomores, expressed in percentiles, and ascendance-submission scores.

The question of low reading ability for the low or experimental group might be raised here also. The *A-S* Reaction Study was tried out on a person of reading ability between the sixth and ninth grade and many of the words were not understood. One wonders then if the low group had been able to read as well as the middle group if their score would have been lower. One also wonders if the low group has developed a defense mechanism against the world to compensate for their feelings of inferiority in an academic situation or discouragement in general

There is no significant difference in ascendance-submission between earning and family-supported students However, the difference between organized and unorganized students yields a critical ratio of 2.2 which means that the organized students are probably more ascendant than the unorganized. Whether the fraternities select the more ascendant freshmen or whether pledging to a fraternity makes one more ascendant is a question for conjecture.

7 *Reading Ability (Thorndike-McCall)*

The reading ability of the three groups in the experiment as measured by the Thorndike-McCall Reading Scale (*T* Scores) is shown in Table 13A

TABLE 13A
READING ABILITY AS MEASURED BY THE THORNDIKE-MCCALL READING SCALE (*T* SCORES)

Low (Experimental)			Middle Control			High Control		
M	σ_M	σ_{dist}	M	σ_M	σ_{dist}	M	σ_M	σ_{dist}
60 18			65.42			69 08		
	63	5 26		64	5.22		81	6 70

The mean score of the low group is 60 18 which corresponds to about a ninth grade reading ability Thirty-three out of 70, or nearly one-half of the total low group, had a reading ability ranging from sixth grade (elementary school) to ninth grade The mean score for the middle group was 65 42 which is just below 12th grade level. The mean score for the high group was 69 08 which corresponds to a reading ability just above the 13th grade level

The difference in means and the significance of differences are presented in Table 13B. There is a critical ratio of 5.8 for the difference between the low and the middle groups; the difference between the middle and the high groups shows a critical ratio of 3 6, and the difference between the low and the high groups shows a critical ratio of 8 5 These are all statistically

TABLE 13B

SIGNIFICANCE OF DIFFERENCES ON THORNDIKE-MCCALL READING SCALE

M minus *L*		*H* minus *M*		*H* minus *L*	
Diff. σ_{diff}	*CR*	Diff. σ_{diff}	*CR*	Diff. σ_{diff}	*CR*
5.24		3.66		8.80	
.90	5.8	1.03	3.6	1.03	8.5

L — Low.
M — Middle
H — High.

significant differences, with the ratio between the low and the high groups strikingly so.

The correlation coefficient was calculated for reading ability and intelligence by the quantitative variates with unequally spaced interval procedure described by Peters and Van Voorhis (14) and used for the correlation between the discouragement-buoyancy and intelligence as indicated above. The r so calculated was +.58 with a standard error of the correlation coefficient of .05. This shows, therefore, that contrary to some prevailing opinions there is not a perfect, or very high, positive correlation between intelligence and reading ability.

There was quite a large range in each of the three groups and considerable overlapping in reading scores. In other words, the low group ranged from sixth to 14th grade ability (*T* score 48 to 73); the middle group ranged from seventh grade to 15th grade ability (*T* score 54 to 81); and the high group ranged from seventh grade to 15th grade ability (*T* score 54 to 89).

The fact that the middle and high groups have some students who have a reading ability as low as the seventh grade indicates strongly the need for remedial reading work for these students who could obviously accomplish so much more if they could read more efficiently. The situation of the low group is much more serious because of the greater numbers who have a reading ability below a minimum which would enable the students to study their college subject matter efficiently. This reading performance must, of course, contribute to their failure in doing satisfactory work in the academic situation. It is probably impossible, however, to raise appreciably the reading performance of the students in the lowest 10 per cent of the college distribution of intelligence; hence the low reading scores of these students appear to point in the same direction as the main theme of this study, namely that such students should be protected from tasks which are manifestly of impossible difficulty for them.

8 *Some Interrelationships between Factors*

In order to study the question of whether combinations of categories might show some effects on discouragement-buoyancy which one category alone did not show, the combined effect of (*a*) status as to social organization and (*b*) source of support was studied in a somewhat informal manner The four possible combinations of these two factors are presented in Table 14 (1 Unorganized-Family-supported; 2. Organized-Family-supported; 3 Unorganized-Earning; 4. Organized-Earning) with the scores of the four groups on (*a*) Horrall Scale of discouragement-buoyancy; (*b*) Percentage of serious problems on Mooney Problem Check List; (*c*) Allport Ascendance-Submission Reactions, (*d*) *ACE* Intelligence Percentiles. The critical ratios between the mean scores of the four different groups are also presented in Table 14

The one critical ratio approaching significance between any two of the four categories is a critical ratio of 2 0 between Horrall discouragement-buoyancy scores of unorganized family-supported students and unorganized earning students, the latter being more buoyant. It is to be noted, however, that the more buoyant group (unorganized-earning) has a higher mean intelligence, 50 45, than the more discouraged group (unorganized-family-supported) which has a mean intelligence score of 45.02.

The percentage of serious problems marked on Mooney goes in the same direction on these two groups as the Horrall discouragement-buoyancy score, the more buoyant group having the smaller percentage of serious problems (30 20) and the more discouraged group having the higher percentage of serious problems (32 40). There is not a significant difference, however, between the two Mooney means, the critical ratio being 0 6.

These two findings suggest that possibly the unorganized student has greater buoyancy when he has the reassurance of earning money, but it is to be noted on the other hand that it might be only the higher intelligence of that group that accounted for its higher buoyancy.

On the slim basis of the data presented in Table 14, with its low critical ratios and in certain cells a small number of students, one might say that if one were family-supported it would make no difference whether one were organized or unorganized. On the other hand if one belongs to a fraternity or a sorority, one may be more buoyant if one is earning one's own money ($N = 5$) rather than being supported by one's family. It appears to be better if one is earning money, to be unorganized than to belong to a fraternity or a sorority

A concealed factor which does not become apparent is one mentioned

TABLE 14
SOME INTERRELATIONSHIPS BETWEEN FACTORS

		Unorganized means	*CR*	Organized means	*CR*	Totals
Family-supported	Horrall Scale	38.22	0.03	38.19		38.21
	Mooney % serious prob.	32.40	0.2	31.70		32.20
	Allport	—5.10	1.7	.55		—3.30
	Intelligence	45.02		44.96		45.00
	N - 102			*N* - 47		
	(*L*-35, *M*-38, *H*-29)			(*L*-18, *M*-14, *H*-15)		149
Critical ratio	Horrall Scale		2.0		0.4	
	Mooney % serious prob.	30.20	0.6		0.4	
	Allport		0.7		0.8	
Earning	Horrall Scale	40.40	0.1	39.40		40.32
	Mooney % serious prob	30.20	2.0	18.00		29.15
	Allport	—2.90	1.0	10.00		—1.80
	Intelligence	50.45		40.28		49.58
	N - 93			*N* - 5		
	(*L*-15, *M*-15, *H*-23)			(*L*-2, *M*-1, *H*-2)		58
Totals	Horrall Scale	38.96				
	Mooney % serious prob.	31.65		30.40		
	Allport	—4.35		1.45		
	Intelligence	46.88		44.51		
	N - 155			*N* - 52		207

Horrall score—larger score, favorable
Mooney score—smaller score, favorable
Allport score—higher positive score, ascendant

L — Low group
M — Middle group.
H — High group

above, that the earning students were predominantly from School *X* amongst whose population the tradition of self-support is well established and in which the academic requirements may be easier than in the other schools. Another confusing issue which is evidenced in the sub *N*'s in unorganized groups is that certain high students from School *W* began to earn money after the subjects of the experiment were selected. Consequently, the cheerfulness of the unorganized-earning quarter of Table 14 may be as much or more due to the addition of high intelligence students from School *W* as to the students from School *X* who are used to self-support and have an easier academic program

The Allport means show the following progression from ascendancy to submission in the four quarters of Table 14. The organized students who are earning money are the most ascendant (+10.00, $N = 5$). The family-supported organized students come next (+ 55) The unorganized students who are earning money are on the submissive side of the Allport scores (—2 90) The family-supported unorganized students come last in the series with the most submissive score (—5.10). What is the meaning of these interrelationships with ascendancy-submission is not clear and the critical ratios involved do not justify much speculation, but the findings suggest that in order to do battle with hard circumstances in the matter of financial difficulties one apparently needs to be more ascendant than one's social group, unorganized or organized (The more submissive students faced with financial problems perhaps have not come to college.) Furthermore the suggestion again arises that fraternities and sororities may tend to select students with already established ascendant rather than submissive traits In any event, as has been said before, it appears likely in this experiment that the Allport traits are not responding to current situations but do represent general personality trends set up before one comes to college It is to be remembered that the subjects of this experiment were freshmen. Possibly a longer period in college would affect Allport ratings more

B. SUMMARY, DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

1. *Summary*

1. The experimental group of the study included all freshmen entering Purdue University in September of 1941, still in school in April of 1942, who were at or below the tenth percentile in the *ACE* Psychological Examination scores, and at or below the thirtieth percentile in the English and Mathematics Entrance Examination scores One control group was chosen from the middle range in Psychological Examination scores, 40th to 60th percentile, and between the 30th and 70th percentile in the English and Mathematics tests. Another control group was selected from the same limits at the top of the distribution as the low (experimental) group had at the bottom, namely, at or above the 90th percentile in Psychological Examination scores and at or above the 70th percentile in the English and Mathematics tests. The middle and high control groups were equated with the low (experimental) group as to sex, academic school at Purdue University, membership in a social fraternity ("organized" or "unorganized"), and financial status, whether earning money or being family-supported. Since the numbers in some of the schools were so small, they were combined with others whose difficulty of subject matter was judged to be about the same, thus making four school groups.

The number in the low (experimental) group was 70, in the middle group, 68, in the high group, 69, making a total of 207 subjects.

2. The mean intelligence test score in terms of percentiles for the low group was 4.80, for the middle group 47.07, and for the high group 87.59.

3. The distribution of intelligence in the four academic schools was markedly different, necessitating a change in the intelligence test limits originally desired. The three groups of subjects (one experimental and two control) were, however, drawn from the same relative position in each academic school group. The means of the Psychological Examination scores in Purdue University percentiles ranged from 3.64 to 5.79 for the low (experimental) group, from 40 83 to 50.52 for the middle (control) group, and from 74.22 to 95.52 for the high (control) group.

4. A new scale was created to measure discouragement-buoyancy in the college situation, the Horrall College Experience Scale. Five items of the trial scale were discarded after it was found that they appeared not to be measuring this particular trait. The final scale consists of seven areas, each to be checked on a nine-point continuum ranging from discouragement to buoyancy.

5. The low group showed genuine discouragement as compared with the middle group, and a much greater discouragement when compared with the high group The discouragement-buoyancy total scores on the Horrall College Experience Scale were 34.60 for the low group, 39.18 for the middle group, and 42 68 for the high group The critical ratio for the difference between the low and the middle groups was 4.7; for the difference between the middle and high groups, 3 5; and for the difference between the low and the high groups, 8.1 These differences are all statistically significant, the difference between the low and the high groups being strikingly so

6. The correlation between intelligence and total discouragement-buoyancy scores shows that there is a positive relationship between these two traits. The r as calculated by the Burr adaptation of the biserial r formula is $+.36$ with an estimated standard error of .06 The r as calculated by the quantitative variates of unequally spaced intervals technique is $+ 52 \pm .05$.

7 The means of the scores on the Chant-Myers Optimism-Pessimism Scale showed these college students to be normal when compared to the mental hospital patients studied in the construction of the original scale, but there were no statistically significant differences between the low, middle, and high groups.

8. The scores on the Mooney College Problems Check List showed the low group to have the greatest number of problems, the middle group to have the next largest number of problems, and the high group to have the smallest number of problems in the following areas: Personal-Psychological Relations, Adjustment to College Work, and Curriculum and Teaching Procedures. The same progression from low to middle to high appeared in the three types of total scores. (*a*) total number of problems (underlined), (*b*) total number of serious problems (circled), and (*c*) percentage of serious problems among total number of problems (percentage of underlined items which were circled).

Because of the way in which items are grouped in the Mooney Check List, elaborate statistical work does not seem justified However, in the area of Adjustment to College Work, the critical ratio for the difference between the low and middle groups is 3.4, for the difference between the middle and the high groups 4.3, and 7 6 for the difference between the low and high groups, the low group showing the greatest number of problems in this area.

9. There was no apparent correlation between ascendance-submission as measured by the Allport Reaction Study and intelligence However, there was a critical ratio of 2 2 between the means of the organized and unorganized students, showing that the organized students are probably more ascendant than the unorganized students.

10. The mean score for reading ability as measured on the Thorndike-McCall Reading Scale was at about ninth grade for the low group, just below 12th grade for the middle group, and just above the 13th grade level for the high group

11. No statistically significant differences appear in total discouragement-buoyancy scores as measured by the Horrall College Experience Scale between organized and unorganized students, between family-supported and self-supporting students, or between men and women students

2. *Discussion*

There are certain areas in the experiment which it appears to the writer might be improved and certain additions which might be made in a further study, as follows· (*a*) It is not known whether the new final scale on discouragement-buoyancy would yield quite the same results with the five discarded items omitted or whether they serve a useful purpose in giving a "padding" to the seven items which were retained in the final scale (*b*) The factor of financial support might be handled in a different manner in a further study; that is, the factor might be classified as family-supported, *partial self-supporting, and complete self-supporting.* (*c*) Other instruments such as *The Social Adjustment Inventory of Washburne* (20), a test showing various phases of emotional and social behavior, might be included in the battery of tests to enlarge the area of student behavior to be studied. (*d*) Some of the instruments used in the study might be omitted in a further study, for instance, the Chant-Myers Optimism-Pessimism Scale inasmuch as it contributes no pertinent information except that the students fall in the "normal" group.

3. *Conclusions*

The conclusions to be drawn from the experiment are as follows: The group low in college ability experiences great discouragement as compared to the middle group and a very great discouragement when compared to the high group, with the high group showing greater buoyancy than the middle group. The factor of being organized or unorganized, being family-supported or self-supporting, being a man or a woman appears to have little to do with the degree of discouragement or buoyancy in the college situation. So far as the results of this study go, the crucial factor is the student's intelligence as compared to the group he is in.

The number of college problems encountered are greatest for the low group, next greatest for the middle group, and smallest for the high group. The *reading ability of the low group is very low, that of the middle group is medium, and that of the high group is highest. There is at the same* time a wide range in each group and considerable overlapping in scores between groups

Those students who are low in intelligence as measured by the *ACE* Psychological Examination appear to constitute a radically different group from those who are in the middle or at the top of the distribution. The daily frustrations and failures and the consequent discouragement of the low intelligence students as mirrored in all significant measurements used in this study place them as a group apart. The middle and high groups in intelligence have apparently a generally similar college experience as indicated by the fact that in all significant measurements of this study there is less difference between the two upper groups than between the middle and low groups The low group is so much farther below the middle group in discouragement than the high group is above the middle group in buoyancy as to make it justifiable to say that students low in intelligence at Purdue University constitute a distinctly separate population whose needs are apparently being exceedingly poorly met at the present time.

The total picture then for the low group is great discouragement and the facing of almost insurmountable problems in the academic situation. The middle group, for whom the level of difficulty of subject matter is adjusted, feels comfortable in the college situation, and the high group experiences a greater buoyancy because of their greater ability to do abstract thinking and thus to succeed easily in the college academic situation.

4 *Recommendations*

The following recommendations are offered in the light of the findings of the present study together with the writer's experience in psychological clinic work with students of low college aptitude and her work as an assistant for two semesters with the elementary psychology course at Purdue University.

1 The above conclusive evidence that the low group experiences great discouragement and fails to achieve success in the college situation strongly suggests that the university should raise entrance barriers, making it impossible for those low in college aptitude to enter a situation in which from the outset they are bound to face discouragement, defeat, and eventually a doubt as to their own ability and worth.

2. Until the university can bring itself to adopt the above more drastic procedure, it should offer a one-year curriculum for the students low in college aptitude, and then guide them into jobs commensurate with their abilities with a feeling that they can perform a worthwhile service to society in general instead of allowing them to leave the university with an overwhelming feeling of failure, defeat, and disillusionment

3. A counselling service staffed by people with special training should be set up by the university to provide efficient, intelligent, and sympathetic help for the problems which not only the low group but also the middle and high groups encounter

4. The reading scores are positive evidence that the university is in urgent need of a remedial reading program for the middle and high groups so that these students may more efficiently prepare the assignments in college courses

5. Lastly, it is hoped that the university, realizing the enormous waste of brain-power which exists, will offer to the group high in intelligence a special curriculum with specially designed courses which would give these brilliant minds an opportunity to develop their latent capacities to the fullest extent and thus enable them to go out after graduation fully equipped, trained, and energized to solve the manifold problems evident in every

field of human endeavor. Extensive efforts are made to increase the output of industry and agriculture in this world crisis, but the greatest advance in progress would be made by utilizing to the utmost the brain-power of the exceptionally gifted students who go through the university with no more opportunity to develop than is offered to the mediocre who never can do the creative thinking possible by the most intelligent members of the student body.

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YOUNG THINKERS AND GREAT ACHIEVEMENTS*

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Outstanding achievement is often correlated with an unbelievably early start The early start may be of great advantage for the maximum development of both "physical" and "intellectual" skills For example, unpublished data assembled by the present writer disclose a surprisingly large number of professional golfers who either were born close to a golf course or who served as caddies when quite young Could this early opportunity to practice golf and thus to acquire early "the feel" of a golf club have been a crucial factor making for subsequent golfing success?

Amram Scheinfeld's data for professional musicians are of interest in this connection. For three groups of noted performers studied by Scheinfeld the mean age at which musical talent was first displayed was 6 2/3 years (50, p. 259). And for 36 virtuosi instrumentalists the mean age at time of making their *professional debuts* was only 13½ years! It seems obvious that in certain kinds of work an early start favors zealous learning thereof and also provides the learner with adequate time for the attainment of a very high level of proficiency prior to the onset of that inevitable decline in enthusiasm which ultimately overtakes all mortals

At Greenfield Village, near Dearborn, Michigan, a guide was recently showing tourists a replica of the jewelry shop in which Henry Ford once worked as a small boy. The guide remarked quite casually that at the time he was working in the shop Ford was so tiny that the jeweler stationed him in the rear of the building—out of sight of the public It seems that the sensitive jeweler did not want the public to know that such a tiny boy was repairing their watches and clocks. Surely, it is not without some sort of significance that Henry Ford, the man who did more to put the world on wheels than any other person in recent history, was working with tiny wheels and gears at a very tender age

In a popular article entitled· "To Become a Great M.D. Begin at 14," Paul de Kruif writes as follows: "I put this question to 24 of the nation's

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most distinguished doctors and microbe hunters: 'How old were you when you decided to study medicine?' The answer is startling: The average age at which these men dedicated themselves to the fight against death was 14½ years" (13, p. 99).

In citing these examples the present writer does not mean to imply that an early start at one's life work will implant potential talent where such talent previously was lacking. On the other hand, when potential ability remains undeveloped for too long a time, subsequent efforts to develop it may be less successful than earlier efforts would have been. All researchers in the field of child psychology today emphasize the importance of the early environment, and the following statement by Miss Tyler would probably be acceptable to most students of this problem.

> Environmentally-produced traits are often so firmly fixed that it is impossible to shake them . . a college freshman who is unusually weak in the vocabulary test given as a part of the college-entrance examination will probably carry some degree of verbal disability throughout his adult years even if he tries to spend extra time in reading and word study since he cannot make up for the development which did not occur years before (54, p. 301).

Like the golfers, the musicians, and the doctors mentioned above, a large number of gifted performers in other fields have displayed similarly their peculiar interest, or aptitude, or both of these traits at exceedingly youthful ages. Over and over again one finds in the biographies of intellectual giants some such statement as the following: ". . . he very early displayed an unusual curiosity with reference to things scientific," or ". . . at an early age he exhibited a keen interest in mechanical toys."

For example, Henry Crew observes that Sir Isaac Newton received his elementary education at the grammar school in Grantham where he early showed great aptitude in making kites, windmills, and other mechanical toys (11, p. 133). And of Fraunhofer, who did epoch-making work in optics and who discovered the solar spectral lines, Crew says.

> When only 12 years old, Fraunhofer began a six-year apprenticeship in the shop of a mirror-maker and glass-blower in Munich. At the age of 21, he was made a member of an important firm of opticians; at the age of 30, he read before the Bavarian Academy of Sciences an account of his discovery of certain dark lines distributed through the solar spectrum—a discovery which enabled him, for the first time, to identify color accurately and hence to measure refractive indices with a precision hitherto undreamed of (11, p. 159).

Florian Cajori remarks similarly of Michael Faraday that in 1805, when he was only 14 years old, and serving as errand boy at a book-store and book-binder near his home:

> . . . he liked to read scientific books which happened to pass through his hands. "I made such simple experiments in chemistry," he [Faraday] says, "as could be defrayed in their expense by a few pence per week, and also constructed an electrical machine" (4, p. 234).

A. Crum Brown says of Justus von Liebig, the noted German chemist:

> At home he employed his time in repeating, as far as the means at his command admitted, the experiments he found described in books, and thus while still a boy attained a theoretical and practical knowledge of chemistry comparable with that of many full-grown professors of chemistry (18, Vol. 14, p. 565).

A statement such as the foregoing may lead the critical reader to suspect exaggeration To spotlight the fact that persons who are able to think at all are often able to do it at amazingly youthful ages, and at the same time to minimize the likelihood of overstatement, this study sets forth the youngest ages at which certain noted individuals have made really important contributions to various fields. As here used, the words "important contributions" mean any contributions at all which are of sufficient merit to be mentioned and discussed in chronologies that have been assembled by specialists within various fields of endeavor—specialists who published their findings under their own signatures and who must, therefore, have tried conscientiously to make (or to obtain) sound evaluations.

Since the present writer is not thoroughly familiar with the several fields cited herein, he is unable to "explain" the contributions listed below any more clearly than the authors whose descriptions are quoted Hence, the almost complete reliance in what follows on verbatim quotations.

The technical terms need not be understood in order to follow the gist of the quotations. In so far as this study is concerned, the significance of the creative contributions cited below lies in the two following facts: (*a*) this work was accomplished in every instance by mere fledglings not one of whom was over 21 years old at time of the indicated achievement, and (*b*) each of these accomplishments is to be found listed in specialized chronologies.

Appleby, John Francis (1840-1917) *Practical Invention*

> It was when only 18, in the employ of a farmer in Iowa County, [Wisconsin] that he first conceived the idea of a binder. He was as-

sisting in the trial of a new reaping machine, binding the sheaves as the grain was cut, when it occurred to him that a machine could be made to do this work. His suggestion was received with jeers from his employer. Nevertheless, during the ensuing year he constructed a model of a twine binder which contained the essential elements of the Appleby Knotter which binds nine-tenths of the grain grown in the world today (15, Vol 1, p. 325)

John F. Appleby made a successful twine binder in 1858 [age 18], but it was not put on the market until 1880, when the price of twine was sufficiently low to make its use economical. Thus the McCormick cutting principle, the Marsh frame, and the Appleby binder were combined to produce the successful modern harvester (20, Vol. 19, p 7)

Austen, Jane (Dec 16, 1775-1817) *Best Books*

Her best-known, if not her best work, *Pride and Prejudice,* was also her first. It was written between October, 1796, and August, 1797 [Ages 20-21], although such was the blindness of publishers, not issued until 1813 (20, Vol. 2, p. 698).

Baglivi, Giorgio (1668-1706) *Medicine*

Already in 1685 [age 17] Baglivi was advocating ipecac as an excellent remedy against Dysentery (5, p 560).

Becquerel, Alexandre Edmond (1820-1891) *Electricity*

Becquerel discovered in 1839 [age 19] that light effects the resistance value of selenium This gave the first photoelectric cell the means of changing light into electric currents (8, p 26).

Bellini, Lorenzo (1643-1704) *Anatomy*

His study of the structure of the kidney, published at the age of 19 (*De structure renum,* 1662) demonstrated among other things that the striations on the cut surface were minute tubules and not cords, as had been supposed His description of the organs of taste is also worthy of note (5, p. 525)

Bischoff, Carl Adams (1855-1908) *Chemistry*

He developed syntheses of aliphatic acids by ketonic esters, 1876 [age 21], (30, p 226)

Blake, William (1757-1827) *Poetry*

His creative faculty found its outlet in these early years in poetry, some of which has survived in the thin volume of *Poetical Sketches,* printed for Blake by his friends in 1783 These pieces were composed between his twelfth and twentieth years . . . they remained unknown and so had no influence on the poetry of their time, but nevertheless were the forerunners of the freer age in poetry which began some 20 years later (20, Vol 3, p 694).

Braille, Louis (1809-1852) *Practical Invention*

Special printing for the blind, which had been known in crude forms since the sixteenth century, was not developed until Louis Braille (1809-1852)—himself blinded by an accident at the age of three—invented his compact alphabet of raised dots (1829) [age 20] Today large libraries of books in many languages, composed on the Braille system, are available to the blind throughout the world (5, p. 734).

Brown, Thomas (1778-1820) *Philosophy*

Concerning young Thomas Brown, Sir James Mackintosh has written as follows "I very early read Brown's *Observations on the Zoonomia* of Dr. [Erasmus] Darwin, the perhaps unmatched work of a boy in the eighteenth year of his age. His first tract on Causation appeared to me the finest model of discussion in mental philosophy since Berkeley and Hume, with this superiority over the latter ." (37, p 336).

Bryant, William Cullen (1794-1878) *Poetry*

He began composing verse at the age of eight, his *Embargo*, necessarily immature, yet withal a lively political satire, was written at thirteen *Thanatopsis*, his masterpiece, was finished when he was eighteen, though not published until six years later in the *North American Review* (23, p 36)

His fame as a poet dates from the almost accidental publication of *Thanatopsis* in the *North American Review* in 1817 One of the editors, Willard Phillips, had told Dr Bryant that he wished William Cullen to contribute, Dr. Bryant found in his son's desk the manuscript of *Thanatopsis, To a Waterfowl,* and a briefer piece, and Phillips excitedly carried them at once to his Cambridge associates. "Ah, Phillips, you have been imposed upon," said R. H. Dana; "No one on this side of the Atlantic is capable of writing such verses" (15, Vol 3, p 201).

"American poetry," says Richard Henry Stoddard, "May be said to have commenced in 1817 with [Bryant's] *Thanatopsis* and *Inscription for the entrance of a wood"* He wrote *Thanatopsis* at Cummington in his 18th year . . (20, Vol 4, p. 300)

Burns, Robert (1759-1796) *The Harvard Classics*

Fourteen immortal poems and songs written by Robert Burns from ages 14 to 21 are included in President Charles W. Eliot's famous five-foot shelf (29, Vol 6, pp 19-26)

Campoamor, Ramón de (1819-1901) *Spanish Literature*

As early as 1838 [age 19] Ramón de Campoamor (1819-1901) came into notice with a romantic play, *Una Muger generosa* (22, p 453)

Candolle, Augustin Pyrame de (1778-1841) *Botany*

In 1796 he went to Paris to continue his botanical studies and at the early age of 21 published his *Historia Plantarum Succulentarum*, a work in four volumes that won him the immediate recognition of the great naturalists Cuvier and Lamarck (3, p 211)

Chatterton, Thomas (1752-1770) *Poetry*

. . he conceived the daring scheme of composing poems and prose pieces in the medieval style and diction, and of palming them off upon the good burghers of the town, as originals which he had unearthed in the muiment room of the church Incredible as it seems, he began this work in his twelfth year. . . Some of the poems, especially *Aella, The Bristowe Trajedie*, and the *Balade of Charitie*, are of remarkable beauty and force; and when we remember that the author of them was scarcely more than a child, they become astonishing (41, p 214).

During his brief career, he produced a considerable number of poems displaying much poetic beauty, love of nature, romantic spirit, and lyric feeling . . . their importance is heightened by our knowledge of the fact that poems of such excellence were written by one who at the time of his death [age 18] was little more than a child . . no one can deny that he was a true poet and that his achievement was simply astounding for one so young (10, p. 233 f).

The immortal Keats paid the following compliment to Chatterton's diction.

"The purest English, I think—or what ought to be purest—is Chatterton's. The language had existed long enough to be entirely uncorrupted of Chaucer's Gallicisms, and still the old words are used Chatterton's language is entirely northern. I prefer the native music of it to Milton's, cut by feet."—Keat's letter to George and Georgiana Keats, Sept 22, 1819 (55, p. 1230).

Coghill, Annie Louisa, née Walker (1836-1907) *Words to Hymn Tunes*

Her popular hymn, *Work for the Night is Coming*, was written in Canada in 1854 [age 18], and published in a Canadian newspaper, from which it passed, without any acknowledgment of the authorship, into Ira D. Sankey's *Sacred Songs and Solos* (16, p 1622).

According to the editor of the *Inter-Church Hymnal*, Miss Coghill's above-mentioned hymn ranks 109th in popularity among some 400,000 church hymns published prior to 1945 (42, p. iii)

Colt, Samuel (1814-1862) *Practical Invention*

From his earliest youth explosives and firearms had always interested him, and on his voyage to Singapore [age 16] he whittled out of wood a model showing his idea of a multi-shot firearm of the revolving barrel type. The perfection of this idea seems to have been uppermost in his mind from the time he made this first wooden model. In 1831 [age 17] he constructed two pistols, one of which exploded; in 1832 [age 18] he sent a description of his idea to the Patent Office in Washington, and in 1833 [age 19] he constructed, in Baltimore, both a pistol and a rifle on the principle for which he subsequently obtained patents in England and France, when he wandered over there in 1835 [age 21] (15, Vol. 4, p 318).

Three inventions enabled the settlers to conquer this country [the western plains of the U. S A]. These were the six-shooter, the windmill, and barbed wire . . . the six-shooter enabled the pioneers to defeat the Indians . .

In 1850 Major George T. Howard of the old Texas army and Captain I S Sutton of the Rangers wrote the following testimonial to the effectiveness of the revolvers "They are the only weapon which enabled the experienced frontiersman to defeat the *mounted* Indian in his own peculiar mode of warfare" (44, p. 856 f.)

Cordus, Valerius (1514-1544) *Pharmacy*

The brilliant Valerius Cordus (1515-1544), of Erfurt, in his short 29 years left permanent traces in science, with and his publication of the first adequate pharmacopoeia, the *Dispensatorium* of 1535 [age 20] (Nurnberg) This set the fashion for similar works, often published by cities such as Basel, Antwerp, and Augsberg (5, p. 486).

Correggio, Antonio Allegri (1484-1534) *Paintings in Oil*

One of his early pictures [Madonna with St Francis] painted in 1514 when he was 19 or 20 years old, is a large altar-piece commissioned for the Franciscan convent at Carpi, representing the Virgin enthroned, with Saints, it indicates a predilection for the style of Leonardo da Vinci. This picture is now in the Dresden Gallery (18, Vol 6, p 437).

Cowley, Abraham (1618-1667) *Poetry*

Cowley was famous as a poet at fifteen . (41, p. 153)

A collection of five poems called *Poetical Blossoms* was published in 1633 [age 15]. A second edition, with the addition of *Sylvia, or dyvers copies of verses,* appeared in 1636 [age 18], and a third in 1637 [age 19]. It is probable that no poet has given more remarkable proofs of precocity He says in his preface that he wrote one of the pieces, the *Pyramus and Thisbe,* at the age of ten, and the *Constantius and Philetus* two years later . In 1638 [age 20], he published a pastoral drama called *Love's Riddle,* written about the age of sixteen On Feb 2, 1638 [age 20], his Latin comedy called *Naufragium Joculare* was played before the university by members of the Trinity College, and was published soon afterwards (17, Vol. 4, p. 1305).

Coxe, A. Cleveland (1818-1896) *Words to Hymn Tunes*

His hymn, "O Where Are Kings and Empires Now?" written in 1839 [age 21] (42, pp iii; 128) was found by the editor of the *Inter-Church Hymnal* to rank about 128th in popularity among some 400,000 church hymns published prior to 1945.

Crane, Walter (1845-1915) *Children's Picture Books*

In 1862 [age 17] his picture, *The Lady of Shalott,* was exhibited at the Royal Academy. . . . In 1864 [age 19] he began to illustrate for Mr Edmund Evans, the colour printer, a series of six-penny toy-books of nursery rhymes, displaying admirable fancy and beauty of design, though he was limited to the use of three colours (18, Vol 6, p. 634)

Curie, Pierre (1859-1906) *Physics*

The following paper is the first of several on the same subject It deals with the development of pressure by electric polarization in hemihedral crystals with inclined forces. The work was done in collaboration with Jacques Curie and appeared in the *Comptes Rendus,* Vol 91, p 294, 1889 [age 21] (38, pp. 547 f.).

Davy, Sir Humphrey (Dec. 17, 1778-1829) *Chemistry*

His first scientific discovery was that of the existence of silica in the epidermis of the stems of reeds, corn, and grasses The intoxicating effects of nitrous oxide when respired were discovered by him on April 9, 1799 [age 20] (18, Vol 6, p 845)

. the anesthetic properties of nitrous-oxide gas were discovered by Sir Humphrey Davy (1799) [age 20], who even suggested that "it may probably be used with advance in surgical operation" (5, pp 722 f)

Davy, Sir Humphrey (Dec. 17, 1778-1829) *Heat*

With reference to Davy's youthful essay on heat, Sir William Thomson (Lord Kelvin) has written as follows.

From the dawn of science till the close of the last century two rival hypotheses had been entertained regarding the nature of heat, each with more or less of plausibility, but neither on any sure experimental basis· one that heat consisted of a subtle elastic fluid permeating through the pores or interstices among the particles of matter, like water in a sponge, the other that it was an intestine commotion among the particles or molecules of matter In the year 1799 [age 20] Davy, in his first published work entitled *An Essay on Heat, Light, and Combinations of Light,* conclusively overthrew the former hypothesis, and gave good reason for accepting as true the latter, by his celebrated experiment of converting ice into water by rubbing two pieces of ice together, without communicating any heat from surrounding matter (18, Vol 11, p 588).

De Graaf, Regner (1641-1673) *Embryology*

De Graaf showed that ova arise in the ovary in 1661 [age 20] (24, p 826).

De la Rive, Auguste Arthur (1801-1873) *Electricity*

De la Rive introduced another manifestation of electro-magnetic effects with his floating battery two electrodes supported by a cork so that they floated in an electrolyte. He also discovered the process of electrogilding, 1831 [age 20] (8, p 18).

Ehrlich, Paul (1854-1915) *Bacteriology*

Ehrlich introduced dried blood smears and improved stain methods, 1874 [age 20] (24, p 855).

Ellis, Edward Sylvester (1840-1916) *Ten-cent Thrillers*

Ellis was the author of *Seth Jones* the most popular of the early ten-cent thrillers, and justifiably selected here as an example of the type Within six months of its release [1860, age 20] more than four hundred and fifty thousand copies of it were sold, not to mention certain foreign printings Its keynote is action; every page is sensational (23, pp. 94 f.).

Euler, Leonhard (1707-1783) *Physics*

Modern histories of physics are likely to mention the fact that in 1727, [age 20] Euler published a dissertation (*Dissertatio phys de sono*), on the mathematical determination of vibration ratios (28, Vol 1, pp 63 f.)

Galilei, Galileo (1564-1642) *Physics*

In 1581 [age 17] while watching a lamp set swinging in the cathedral of Pisa, he observed that, whatever the range of its oscillations, they were invariably executed in equal times The experimental verification of this fact led him to the important discovery of the isochronism of the pendulum He applied the new principle to the timing of the human pulse (19, Vol 9, p 979)

Gautier, Théophile (1811-1872) *Poetry*

The *Comédie de la Mort,* which appeared (1832) [age 21] is one of the most remarkable of French poems . (18, Vol. 10, p 117).

Goodricke, John (1764-1786) *Astronomy*

At the age of 18 he discovered the period and law of Algol's changes He first saw the star lose light on 12 Nov, 1782, and observed it at York every fine night from 28 Dec. to 12 May The results were communicated to the Royal Society in a paper entitled "A Series of Observations on and a Discovery of the Period of the Variations of the Light of the Bright Star in the Head of Medusa, called Algol" (*Phil. Trans* lxxiii 484), and in a supplement, "On the Periods of the changes of Light in the Star Algol" (*ib.* lxxiv 287) His suggested explanation of the phenomenon by the interposition of a large dark satellite still finds favour The merit of the research was recognized by the bestowal of the Copley medal in 1783 [age 19]

His discoveries of the variability respectively of B Lyrae and of σ Cephei dated from 10 Sept and 19 Oct. 1784 (*ib* lxxv 153, lxxvi 48) [age 20] He perceived the double periodicity of the former star in 12^d 19^h, a determination regarded by him as merely provisional (Schonfeld's period is nearly three hours longer), and accounted for the observed changes by the rotation on an axis considerably inclined to the earth's orbit of a bright body mottled with several large dark spots For σ Cephei he gave a period of 5^d 8^h $37\frac{1}{2}^m$ (10^m too short), remarking that such inquiries "may probably lead to some better knowledge of the fixed stars, especially of their constitution and the cause of their remarkable changes" Goodricke died at York, in his twenty-second year, on 20 April 1786 (17, Vol 8, p 137)

Grotthuss, Christian Johann Dietrich (1785-1822) *Electricity*

C J. D Grotthuss (1785-1822), a Prussian, printed in Rome in 1805, when he was only 20 years of age, a theory of electrolysis which has served as a foundation upon which nearly all subsequent theories have been built (11, p. 236 f)

The apparent migration of the products of electric decomposition called forth several curious theories, but the one which held its ground for over half a century and is still described in textbooks was proposed by Ch. J. D. von Grotthuss (1785-1822). . . . He is best known by his paper, first published at Rome in 1805, when he was only 20 years old . . (4, pp. 215 ff.).

Halley, Edmund (1656-1742) *Astronomy*

With a telescope of 24 feet he observed a lunar eclipse on 27 June 1675 [age 18] in Winchester Street, and at Oxford a remarkable sun-spot in July and August, 1676 [age 19] (*Phil. Trans.* xl. 687), and the occultation of Mars by the moon on 21 Aug 1676 [age 19] (*ib.* p 683). Before he was 20 he communicated to the Royal Society a "Direct and Geometrical Method of finding the Aphelia and Eccentricity of the Planets" (*ib* p. 683), finally abolishing the notion of a centre of uniform motion; invented shortly afterwards an improved construction for solar eclipses, and noted defects in the theories of Jupiter and Saturn. For the correction of these he perceived that a revision of the places of the fixed stars was indispensable, and with the design of supplementing in the southern hemisphere the labours of Flamsteed and Hevelius in the northern, he left the university without a degree, and embarked for St. Helena in November, 1676 [age 19 or 20] . . . the climate proved unfavourable, and by assiduous observations during 18 months with a 5½-foot sextant he succeeded in determining only 341 stars. His enterprise, however, laid the foundation of austral stellar astronomy, and earned for him from Flamsteed the title of the "Southern Tycho" In the course of the voyage he improved the sextant, collected a number of valuable facts relative to the ocean and atmosphere, noted the equatorial retardation of the pendulum, and made at St Helena, on 7 Nov., 1677 [age 21], the first complete observation of a transit of Mercury (17, Vol. 8, p. 988).

Hare, Robert (1781-1858) *Chemistry*

In 1801 [age 21] he discovered the oxy-hydrogen blowpipe, source of the highest degree of heat then known, which enabled him to fuse the most refractory substances and led to the founding of the platinum industry and the development of limelight and allied illuminators (15, Vol. 8, p 263).

This source records a real landmark in scientific discovery, the invention of the oxy-hydrogen blowpipe by Robert Hare, a student only 21 years of age . . . it is on subsequent improvements to his fundamental idea that all modern methods of cutting and welding metals are based

Even with his original apparatus, he managed to melt many substances previously regarded as infusible . . The present oxy-hydrogen blowpipe gives a much greater heat, and with its aid armour-plate two feet thick can be cut into sections and steel buildings rapidly taken apart. All this we owe, essentially, to Robert Hare (31, p 233)

Holmes, Oliver Wendell (1809-1894) *Poetry*

In September of 1830 [age 21] he conceived a poem that had . . . to do with an old worn-out ship, but it came from the heart all the same and was written furiously, in anger and indignation

The frigate *Constitution—Old Ironsides*—whose victorious return to harbor Boston had once been greeted with such wild joy, lay now rotting at the wharf The government announced suddenly, tersely, that the vessel was taking up too much room and must be scrapped. Boston protested, the whole country protested, but with no result. Abiel Holmes [Oliver's father] was almost ill over it, Oliver, bursting in the door one afternoon, found him sitting down moodily at his desk, trying to compose a letter to the *Boston Daily Advertiser*. . .

Oliver went upstairs and, sitting down by the western window, got out pen and paper The lines poured from him, swept from him in a tide It was as though he were writing someone else's poem, dictated carefully by its author and transcribed by Oliver Holmes . .

There were three stanzas Oliver copied them, finding very little to change. It was late when he took the poem downstairs. His father was still at his desk, Saurin's *Sermons* lay open before him Silently, Oliver laid his poem on the desk and left the room.

A moment later his father called him. When Oliver came in Abiel Holmes was standing by the desk, the poem in his hand He began to speak, and his voice choked With enormous surprise and a great lift of the heart, Oliver, looking up, saw tears in his father's eyes, saw that the hand holding his verses was trembling

The poem, published next day in the *Advertiser*, swept Boston like wildfire, then reached beyond Boston all over the country Printed in broadsides, the verses were sold on the streets in Washington The government, overwhelmed, gave orders that the frigate *Constitution* be preserved

In Boston a shout of triumph went up And in Boston, Cambridge, and far beyond the river Charles, Oliver Wendell Holmes, son of the Reverend Dr. Abiel Holmes of Holmes Place, was famous (1, p 57 ff).

Horrocks, Jeremiah (1619-1641) *Astronomy*

The career of Horrocks is, for its brevity, one of the most remarkable on record He had no help but in his own enthusiasm, time and means were alike denied him Sir John Herschel calls him[1] "the pride and boast of British astronomy." (*Treatise on Astronomy*, p 86 n) (17, Vol 9, p. 1269)

Horrocks was a brilliant young man, and before his death on Jan 3, 1621, when in his 22nd year, he had considerably advanced the lunar theory, reduced the solar parallax to 14"; suggested perturbations of the moon's orbit as due to the disturbing action of the sun; made observations of the tides; and investigated the irregularities of motion of Jupiter and Saturn (20, Vol. 11, p. 754).

. . . during his short life of [less than] twenty-two years. "He was the first to predict and observe the transit of Venus in 1639 [age 20]; to reduce the sun's parallax nearly to what it has since been determined, to discover the orbit of the moon to be an ellipse about the earth . . . to devise the beautiful experiment of the circular pendulum for illustrating the action of a central force; and to commence a regular series of tidal observations for the purpose of philosophical enquiry, besides all which, he effected improvements in different astronomical tables, recommended the adoption of decimal notation, detected the inequality in the mean motion of Jupiter and Saturn, and wrote his opinions upon the nature and movements of comets (51, p. 58).

Joule, James Prescott (Dec. 24, 1818-1889) *Heat and Thermodynamics*

In 1835 he began with his brother Benjamin to study under Dalton, who was then president of the Manchester Literary and Philosophical Society. Dalton taught the boys algebra and geometry, and had just introduced them to chemistry when an attack of paralysis disabled him. But from this distinguished chemist, Joule received his first inducement to undertake the work of an original investigator. A room in his father's house was allotted to him as a laboratory, and he began electrical and magnetic experiments, which bore their first fruit in a published paper "On an electro-magnetic Engine" (Sturgeon, *Annals of Electricity*, 1838) [age 19]. Various other papers on magnetism and electro-magnetism followed: one of these, "On Electro-magnetic Forces" (ib. 1840) [age 21], describes the earliest attempt known to measure an electric current in terms of a unit. A unit current is defined by Joule as one which, if allowed to pass for an hour through a water voltmeter, will decompose nine grains of water.

In a paper "On the Production of Heat by Voltaic Electricity" (*Proc. R.S.* 17 Dec, 1840) [age 21] the first of the great laws with which Joule's name is imperishably connected was announced (17, Vol. 10, p. 1097).

Keats, John (1795-1821) *Poetry*

His odes have never been surpassed, and when he was only 20 he wrote the sonnet, *On First Looking Into Chapman's Homer*, that many critics regard as the best in the language (2, p. 270).

On coming to London the young poet was accustomed to spend his evenings reading with his friend, Cowden Clarke. One of the books they thus attacked was a borrowed copy of Chapman's *Homer*, which they read far into the night. On coming down to breakfast next morning, Clarke found awaiting him, this sonnet (*On First Looking Into Chapman's Homer*), *which Keats had written since leaving him a* few hours before. This was sometime during the summer of 1815, when Keats was only 20 years of age, and had as yet done nothing to show his power as a poet. Yet the sonnet is not only his best, but is one of the best of all English sonnets (25, p. 679)

Kestner, Karl (or Koestner, Karl) (1803-1870) *Chemistry*

Kestner prepared r-tartaric acid (1822) [age 19] (30, p. 233)

Kirchhoff, Gustav Robert (1824-1887) *Electricity*

In his initial work [1845, age 21] Kirchhoff discussed the passage of an electric current through a plane surface, and concluded his discussion by setting up the two laws named for him (28, Vol 1, p. 163)

Laennec, René Théophile (1781-1826) *Pathology*

Gerald Webb's *Memoir of Laennec* (Hoeber, 1928, p. 51) describes how Laennec, noting that clinicians confounded peritonitis with enteritis, observing peritonitis at autopsies, and following his study of six carefully worked up autopsies, wrote an article on this disease in 1802 [age 21] (33)

Leibnitz, Gottfriend Wilhelm von (1646-1716) *Philosophy*

Leibnitz, not yet 21 years of age, was already the author of several remarkable essays. In his bachelor's dissertation, *De principio individui* (1663) [age 17], he defended the nominalistic doctrine that individuality is constituted by the whole entity or essence of a thing, his arithmetical tract, *De complexionibus,* published in an extended form under the title, *De Arte combinatoria* (1666) [age 20], is an essay towards his life-long project of a reformed symbolism and method of thought, and besides these there are four juridicial essays, including the *Nova methodus docendi disdendique juris,* written in the intervals of his journey from Leipsic to Altdorf. This last essay is remarkable, not only for the reconstruction it attempted of the *Corpus Juris,* but as containing the first clear recognition of the importance of the historical method in law. Leibnitz printed his *Nova methodus* in 1667 [age 21] (18, Vol 14, p. 418)

Leopardi, Giacomo (1798-1837) *Poetry*

At 18 he produced a poem of considerable length, the *Appressamento alla Morte.* This juvenile work was succeeded (1819) [age 21] by two lyrical compositions which at once placed the [Italian] author upon the height which he maintained ever afterwards. The ode to *Italy,* and that on the *Monument to Dante Erected at Florence* . . these odes are surprisingly exempt from the failings characteristic of young poets. They are remarkably chaste in diction, close and nervous in style, sparing in fancy, and almost destitute of simile and metaphor, antique in spirit, yet pervaded by modern ideas, combining Landor's dignity with a considerable infusion of the passion of Byron (18, Vol 14, p. 464)

Lewis, Matthew Gregory (1775-1818) *Best Books*

Gothic romances were also produced by Matthew Gregory Lewis (1775-1818), whose *Monk* [1796, age 20] was the most popular book of its time (41, p 254).

In 1794 he became attache to the British Embassy at the Hague Here in 10 weeks . he wrote the *Monk*, having been induced to go on with it by his interest in the *Mysteries of Udolpho* . . The book hit the public taste . he became famous at the age of 20, and was received in the highest society. He sat in the House of Commons from 1796 [age 21] to 1802 for Hindon, Wiltshire (17, Vol 11, p. 1071)

Liebig, Justus von (1803-1873) *Chemistry*

Liebig discovered fulminic acid in *1819* [age 16] (30, p 233)

he concluded, in 1824 [age 21] his investigations on the composition of fulminates (20, Vol 14, p. 37

Marconi, Marchese Guglielmo (1874-1927) *Radio Transmission*

In the summer of 1894, a young Italian, Guglielmo Marconi, 20 years of age, chanced to read an article describing the work of Hertz, who had died earlier in the year It was there that the young experimenter got his idea of using the radiated Hertzian waves for communication (53, p 749)

In 1895 [age 21], Marconi transmitted signals one mile without wires (8, p 70).

Mendelssohn-Bartholdy, Jakob Ludwig Felix (1809-1847) *Orchestral Music*

In Aug. 1826 Felix's overture to *A Midsummer Night's Dream* was performed . he was only 17½ years old, but in later years he rarely equalled and never surpassed this work, which, written in the years of Beethoven's last quartets, belongs not only to fairyland but to an orchestration which Rimsky-Korsakov might have thought up-to-date (20, Vol 15, p 243)

. . we may safely assert that in no later work does he exhibit more originality of thought, more freshness of conception, than in this delightful inspiration which, though now [c 1885] nearly 60 years old, still holds its place at the head of the most brilliant achievements of our modern schools . Henceforth—we must speak of him, not as a student, but as a mature and experienced artist (18, Vol. 16, p 7)

Millais, Sir John Everett (1829-1896) *Paintings in Oil*

His next important picture, *Christ in the House of His Parents*, or *The Carpenter's Shop* (*1850*) [age *21*] [represents] a supposed incident in the childhood of our Lord treated in a realistic manner (20, Vol 15, p 494)

Milton, John (1608-1674) *Poetry and Words to Hymn Tunes*

Although his influence on English hymn-writing has been slight, his paraphrase of the 136th Psalm entitled *Let us, with a Gladsome Mind,* written in 1623 at the age of 15, is now in extensive use (16, p 737)

His first notable poem, the *Hymn on the Nativity,* was written in his twenty-first year, in 1629, while he was still at Cambridge. It strikes the high and serious note that was to characterize all his poetry (10, p 170)

The magnificent ode *On the Morning of Christ's Nativity* (1629), which deals with the signs and portents filling the world at the Saviour's birth, was written at 21. It showed clearly, or might have shown to anyone who had eyes to see, that another mighty poet had been given to England (41, p. 160).

In 1629, while Milton was a student at Cambridge, and only 21 years old, he wrote a fine lyrical poem, entitled *On the Morning of Christ's Nativity* These 244 lines of verse show that he did not need to be taught the melody of song any more than a young nightingale (27, p 243)

Montalvan, Juan Perez de (1602-1638) *Spanish Comedies*

Montalvan was already known in 1619 [age 17] by his comedy Morir y disimular . . (22, p 311).

Morphy, Paul (June 22, 1837-1884) *World Championship Chess Play*

At the age of 12 he was recognized as the strongest player in New Orleans . .

By urgent solicitation of the Committee of Management he was induced to participate in the first American Chess Congress, meeting at New York City in the fall of 1857 [age 20] His overwhelming success here and in his later games with American experts gave him immediate recognition as the foremost American player .

In June 1858 [age 20 or 21] he sailed for England, being desirous of testing his strength against Howard Staunton, the foremost English player and writer on chess, who had refused an earlier challenge, and other European experts . In Paris, matches were arranged with Harrwitz, Mongredien, and Anderssen, the greatest European expert, all of which Morphy won decisively . (15, Vol. 13, p 194)

Morphy never gained the opportunity to meet Staunton The "European Champion," upon Morphy's arrival, told him he would meet him "at some later date." Morphy then toured Europe awaiting Staunton's action Morphy defeated Anderssen, the conqueror of Staunton, and a score of others of international fame He won so easily that the matches bore no resemblance to a contest Europe joined America in declaring Morphy champion of the world, whereupon chess enthusiasts of both continents demanded that Staunton meet Morphy, or retire Staunton replied by announcing retirement in 1858 (40, pp 331 ff.).

In April 1859 [age 21] he sailed via England for New York, acclaimed as the recognized champion of the world and as an unparalleled chess genius (15, Vol. 13, p 194).

Olbers, Heinrich Wilhelm Matthias (1758-1840) *Astronomy*

. in *1779* [age *21*] while watching by the sick-bed of a fellow student, he devised a method of calculating cometary orbits which made an epoch in the treatment of the subject, and is still extensively used (18, Vol. 17, p 752)

Overton, James Bertram (1869-1937) *Botany*

The eyespot in the spermatozoid of *Fucus* was reported by Guignard (1889) to arise from a plastid in the antheridial cell although Overton concluded (1889) [age 20] that it was formed *de novo* in each young zoospore of the green algae he studied (48, p. 167)

Pacinotti, Antonio (1841-1912) *Electrical Engineering*

If the first chapter in the history of electrical engineering, as distinguished from electrical science, may fairly be said to begin with Kelvin's *solution of the problems connected with the laying of the* Atlantic cable, in 1885, then the second chapter begins with the invention of the slotted iron-ring armature by Pacinotti while he was serving *as a soldier in the campaign of Garibaldi in 1859 . . [age 18] (11,* p 288)

Paget, Sir James (1814-1899) *Pathology*

After attending school at Yarmouth, James was appointed to a general practitioner until 1834, when he entered St Bartholomew's Hospital, London. It was during his first winter session that he detected *Trichina spiralis,* a minute parasite infecting the human muscle (age 20 or 21). R Owen who gave these parasites their scientific name, is usually credited with the discovery, but he merely confirmed what Paget had detected (20, Vol 17, p 29).

Paget (1835) [age 20 or 21] showed that these bodies (*Trichina spiralis*) were round worms . (43, p. 27).

Pascal, Blaise (1632-1662) *Mechanical Calculators*

At the age of 19 he invented a computing machine that served as a starting point in the development of the mechanical calculation that has become so important in our time. That he should have been permitted to present one of these machines to the king and one to the royal chancellor shows the esteem in which he must have been held (52, p 382).

Péligot, Eugène Melchior (1811-1890) *Chemistry*

Peligot successfully investigated the constitution of methyl alcohol, 1831 [age 20] (30, p 120)

Perkin, Sir William Henry (1838-1907) *Chemistry*

In 1856 occurred a discovery of far-reaching import. Sir William Henry Perkin, working in the laboratory of A W Hofmann, then a professor at the Royal College of Chemistry in London . . accidentally discovered [at age 18] among the oxidation products of aniline with chromic acid a compound exhibiting tinctorial properties. It was the first synthetic dye (26, p 526)

So this lad of eighteen, seeking to synthesize quinine discovered the first aniline or "coal-tar" dye, and became the father of the modern dye-stuff industry (31, p 95)

Philidor, François André Danican (1726-1795) *World Champion Chess Play*

Giacchino Greco, of Italy, was ranked as the greatest chess player in the 17th century, and François Andre Danican, famous French musical composer, known as "Philidor" in chess circles, was champion of the 18th century He defeated the best in his own country, the champions of Spain, the finest players in England and then . when he was only 21 years of age, met Philip Stamma, a marvelous Syrian, and, in a match of 10 games, won 8 and lost 1, the other being a draw (40, p 331)

The middle of the 18th century inaugurates a new era in chess 'The leading man of this time was François Andre Danican Philidor. He was born in 1726 and was trained by M de Kermar, Sire de Légal, the star of the Café de la Régnence in Paris, which was the centre of French chess until early in the 20th century In 1737 [age 21] Philidor visited England, and defeated the Arabian player, Phillip Stamma, by eight to one and one draw (20, Vol 5, p 432).

Pope, Alexander (1688-1744) *Poetry*

He began his career early His *Pastorals,* written when he was 17 were published in 1709 [age 21] (41, p 200)

. one evening I came upon a poem which enthralled me from the first line It was the only poem I ever committed to memory in all my life, of my own free choice That very night the lines sang through my head as I fell asleep And a thousand times in later years they came humming up like lazy bees on mignonette.

It was a poem on solitude , in these simple lines I found my deepest philosophy of life

One evening, when I was sixty-six, I picked up a book of verse and thumbed idly through it I chanced upon this poem I read it with an even deeper thrill than half a century earlier And—you may find it hard to believe—for the first time I learned its author, Alexander Pope Pope, who as a child had realized that his own life was to be "one long disease" Pope, the hunch-backed dwarf and master of the clearest verse ever written by man. But what bowled me over, that evening, was the discovery that Pope was only 12 years old when he wrote those lines (46, pp 175-177)

Many scholars refuse to believe that Pope wrote the *Ode to Solitude* at the age of 12 as Pope claimed to have done. One finds this doubt expressed repeatedly. For example, note the following skeptical comment:

Pope was 21 when he sent the *Ode to Solitude* to Cromwell, and said it was written before he was 12 years old. He may have retouched this, in all probability he did; perhaps every line of it was written when he was 21; but there is abundance of external evidence of his extraordinary precocity as a metrician (18, Vol 19, p 483).

The *Essay on Criticism* [written at age 21] is a marvelous production for a young man who had scarcely passed his maturity when it was published. To have written lines and couplets that live still in the language and are on everyone's lips is an achievement of which any poet might be proud, and there are at least 20 such lines or couplets in the poem (14, p. 29).

Porta, Giambattista della (1543-1615) *Photography*

The first clear and unequivocal description of (the Camera Obscura) occurs in the *Magiae Naturalis* of Giambattista della Porta (1543-1615). In the first edition (1558), written when he was 15 years old, Porta described a camera obscura, using a pinhole, and stated that it could be used as an aid in sketching by those who would not otherwise possess the ability to do it well (53, p. 427)

Porta, John (1540-1615) *Electricity*

John Porta (1540-1615) wrote of "sympathetic needles" magnetized by the lodestone, mounted on separate dials with letters around their margins, in 1558 [age 18]. When one needle turned the other moved to the same letter (8, p. 9)

Raphael, Sanzio (1483-1520) *Paintings in Oil*

The fourth painting executed for this town [Citta di Castello], for the church of S Francisco, is the exquisitely beautiful and highly finished Sposalizio, now in the Brera at Milan, signed and dated RAPHAEL VRBINAS MDIII [age 20]. This is closely copied both in composition and detail from Perugino's painting of the same subject now at Cain, but is far superior to it in sweetness of expression and grace of attitude (18, Vol. 20, p. 275)

Ritchie, Edward Samuel (1814-1895) *Electricity*

In 1833 Ritchie [age 19] gave up the use of steel magnets in his experimental work and turned to electro-magnets . . . with important results for the construction of electrical machines (28, Vol. 1, p. 111).

Ritter, Johann Wilhelm (1777-1895) *Electricity*

The 21-year-old Johann Ritter accepted Humboldt's conception: at the contact point of two bodies there occurs always an action effective in a definite direction which is electric in nature and which depends upon the chemical properties of the two bodies . . . He added these actions algebraically and obtained the following sum . . . (28, Vol 1, p. 73).

Rossetti, Gabriel (1828-1882) *Poetry*

Even as a young man he came into his full inheritance, and he wrote his best known poem, *The Blessed Damozel,* before he was 20 (2, p 318)

. . written before the poet's nineteenth birthday *The Blessed Damozel* [is] his best known and most typical poem. . The poem reads like a dreamy improvization, and with its enchanting harmonies, its pellucid diction, its sensuous mystery, pictorial magnificence, and medieval setting, it is a beautiful symbol of romance at its best (25, p. 718)

Rossini, Gioachino Antonio (Feb. 29, 1792-1868) *Musical Composition*

These pieces were all successful, but *Tancredi,* written for the Teatro San Fenice at Venice, in 1813 [age 21], produced a veritable furore The name of the young *maestro* was now famous (18, Vol 20, p. 861)

Tancredi, produced at the Fenice, Venice [age 21] made him famous. . Traces of Paer and Paisiello were undeniably present in fragments of the music But the sweetness and clarity of such melodies as "Mi rivedrai, ti rivèdro" and "Di tanti Palpiti," conquered Venice. Italians would sing "Mi rivedrai" in the law courts until called upon by the judge to desist Rossini continued to write operas for Venice and Milan during the next few years, but without repeating the success of Tancredi (20, Vol. 19, p 567 f)

Rudbeck, Olaf (1630-1702) *Anatomy*

Olaf Rudbeck (1630-1702) of Sweden, a student at the University of Padua, on January 27, 1651 [age 21], discovered the lymphatic vessels of the intestine, distinguishing them from the lacteals (5, p 521)

Sanchez, Francisco (1562-1632) *Philosophy*

Francisco (was) a Portuguese physician of Jewish parentage, professor of philosophy and physic at Toulouse, where he died at the age of 70 in 1632, whose ingenius but sophistical writings (*Quod nihil scitur,* 1581) [age 19] mark the high-water of reaction against the dogmatism of the traditional schools of his time (18, Vol 21, p. 255).

Schelling, Friedrich Wilhelm Joseph (1775-1854) *Philosophy*

With characteristic zeal and impetuosity Schelling had no sooner grasped the leading ideas of Fichte's new mode of treating philosophy than he threw together the thoughts suggested to him in the form of an essay, which appeared under the title *Ueber die Moglichkeit einer Form der Philosophie uberhaupt,* towards the end of 1794 [age 19] . . it showed such power of appreciating the new ideas of the Fichtean method that it was hailed with cordial recognition by Fichte himself, and gave the author immediately a place in popular estimation as in the foremost rank of existing philosophical writers. The essay was followed up in 1795 [age 20] by a more elaborate writing, *Vom Ich als Princip der Philosophie, oder uber das Unbedingte im menschlichen*

Wissen, which, still remaining within the limits of the Fichtean idealism, yet exhibits unmistakable traces of a tendency to give the Fichtean method a more objective application, and to amalgamate with it Spinoza's more realistic view of things (18, Vol. 21, p 390)

Schneckenburger, Max (1819-1849) *The German National Anthem*

Max Schneckenburger (1819-1849), wrote *Die Wacht am Rhein* [1840, age 21] which 30 years later, became a national song (49, p 535)

Schubert, Franz Peter (1797-1828) *Songs*

Of [his] songs it is impossible, within the present limits, to give even a sketch They number over 600, excluding scenas and operatic pieces, and they contain masterpieces from the beginning of his career to the end. *Gretchen am Spinnrade* was written when he was 17, *Erlkonig* when he was 18, then there follows a continuous stream which never checks or runs dry (20, Vol 20, p 107)

Shelley, Mary Wollstonecraft (1797-1851) *Best Books*

Frankenstein, published in 1851, when Mary Shelley was at the utmost 21 years old, is a very remarkable performance for so young and inexperienced a writer; its main idea is that of the formation and vitalization, by a deep student of the secrets of nature, of an adult man, who, entering the world thus under unnatural conditions, becomes the terror of his species, a half-involuntary criminal, and finally an outcast whose sole resource is self-immolation (20, Vol. 20, p 483).

Siemens, Sir William (1823-1883) *Practical Invention*

. . he visited England at the age of 19 in the hope of introducing a process in electroplating invented by himself and his brother Werner. The invention was adopted by Messrs Elkington, and Siemens returned to Germany . In 1844 [age 21] he was again in England with another invention, the "chronometric" or differential governor for steam engines (19, Vol 20, p. 619)

[The] "chronometric governor" for steam engines [was] devised by Werner and worked out by William . The "governor" was an instrument of extreme ingenuity; it was fully appreciated by leading engineers, and obtained prizes from the Society of Arts in 1850 and at the exhibition of 1851 (17, Vol. 18, p. 241)

Solis, Antonio de (1610-1686) *Spanish Plays*

He first became known in 1627 [age 17] with his play *Amor y obligacion* . (22, p. 397)

Stokes, William (1804-1878) *Medical Aids*

While still a medical student he published in 1825 [age 21] a small treatise on the Use of the Stethoscope, the first systematic treatise in the English language (39, p 302).

Stokes at once became famous as a teacher of medicine, and in the great epidemic of typhus in Dublin in 1828 his exertions in the treatment of the poor was conspicuous (17, Vol 18, p 1289)

Swammerdam, Jan (1637-1680) *Histology*

. Swammerdam was the first to observe and describe the blood corpuscles As early as 1658 [age 21] he described them in the blood of the frog, but not till 57 years after his death were his observations published by Boerhaave, and therefore, he does not get the credit for this discovery Publication alone, not first observation, establishes priority, but there is conclusive evidence that he observed the blood corpuscles before either Malpighi or Leeuwenhoek had published his findings (36, p 70)

Thomson, Sir William (Lord Kelvin) (1824-1907) *Geology*

Thomson at 21 years had gained experience in three universities—Glasgow, Cambridge, and Paris—had published a dozen original papers, and had thus established for himself a reputation in mathematical physics (17, 2nd suppl Vol. 3, p 508)

As early as 1842 [age 18], Lord Kelvin had published in a paper which appeared in the Cambridge and Dublin *Mathematical Journal*, the germ of his theories about the age of the earth . the resulting controversy among biologists, and geologists has lasted until the present day (35, p 1884)

Trommsdorf, Johann Bartholomaus (1776-1837) *Wave Motion*

In his experiments on sound Trommsdorf used open tubes such as are generally employed today He observed the changing form of the flame as soon as the tube began to vibrate His findings are published in the *Erfurt gelehrte Zeit, Bd.* 58, S 457, 1794 [age 18] (28, Vol 1, p 87)

Unverdorben, Otto (1806-1873) *Chemistry*

Unverdorben discovered aniline, 1826 [age 20] (30, p 233)

Aniline, phenylamine of aminobenzene, an organic base [was] first obtained from the destructive distillation of indigo in 1826 [age 20] by O Unverdorben, who named it Crystallin ($C_6H_5NH_2$) (20, Vol. 1, p 959)

Viviani, Vincenzo (1622-1703) *Physics*

The "Torricellian experiment" was [first] carried out in 1643 in Florence by Vincenzo Viviani (1622-1703), who at 17 had become a pupil of Galileo, and was now studying (age 21) under the direction of Torricelli (4, p. 65)

Viviani, a pupil of Torricelli, in 1643 [age 21], actually carried out the experiment, and with great success. This was the first real barometer in history (12, p 61)

Walker, Frances (1809-1874) *Entomology*

F Walker erected the lepidopterous family Sesiidae, 1838 [age 19] (21, p. 845)

Waller, Edmund (1606-1687) *Poetry*

Among the first writers to use the closed couplet consistently was Edmund Waller (1606-1687). As early as 1625 [age 19], in lines on *His Majesty's Escape at Saint Andrew,* he set the steady, measured pace which succeeding poets were to follow with military precision for more than a century (41, p. 177).

Weber, Henry Adam (1845-1912) *Chemistry*

H. A. Weber isolated sulphur sesquioxide, 1864 [age 19] (30, p. 71).

Weber, Wilhelm Eduard (1804-1891) *Wave Motion*

Wave motion was made the subject of careful study on the part of Wilhelm Weber and his brother, Ernst Heinrich Weber (1795-1878), who published, in 1825 [Wilhelm age 21], their work entitled Wellenlehre (4, p. 280).

Westinghouse, George (1846-1914) *Practical Invention*

In 1865 [age 19] he invented a device for replacing derailed cars and also a reversible steel railway frog (20, Vol. 23, p. 538).

Wheatstone, Sir Charles (1802-1875) *Telephonic Communication*

After [successful] study of methods for transmitting sound, he coined the word "telephone," in 1821 [age 19] (8, p. 18).

At the age of 21 he commenced business in London as a musical instrument maker. A few months after he contributed a paper to Thomson's *Annals of Philosophy* on his early experiments on sound (17, Vol. 20, p. 1346).

Wilkie, Sir David (1785-1841) *Paintings in Oil*

His *Village Politicians* and *Blind Fiddler* (commissioned by Sir George Beaumont), were exhibited at the Royal Academy in 1806 and 1807 [age 21] (20, Vol. 23, p. 604).

Woodhull, Alfred Alexander (1810-1836) *Words to Hymn Tunes*

His hymn, *God of the passing year to Thee,* appeared as No. 406 in the official edition of Presbyterian *Psalms & Hymns,* in 1829 [age 19]. It has attained to extensive use in the altered form as *Great God of Nations, Now to Thee* . . . It is an *American National Thanksgiving* hymn (16, p. 1292).

Young, John Richardson (1782-1804) *Physiology*

Young's name would by now have been forgotten, had it not been for his original work of investigation done as a student and published in his inaugural thesis for the degree of M.D. . .

The thesis, entitled *An Experimental Inquiry Into the Principles of Nutrition and the Digestive Process* (1803) [age 21], was republished in Charles Caldwell's *Medical Theses* (Vol. I, 1805). It begins with some general facts relating to the digestibility and digestion of "nutrien-

> tia," and then describes Young's experiments. The most important of these were made upon large frogs, into whose stomach smaller frogs, living and dead, and various materials were introduced for varying lengths of time, to be removed as desired for later examination, or from whose stomachs gastric juice was removed with a tea-spoon for chemical examination. His discoveries showed that gastric juice is itself acid and that its acidity is not the result of fermentation, as had been previously thought, that it is on account of its acidity that it dissolves the bones of such animals as are swallowed whole and sometimes alive by snakes, frogs, toads, etc., that no digestion can take place so long as the tissues swallowed are alive, even if they be paralyzed, but that it begins the moment they die, that swallowed live creatures do not begin to digest until they have died of asphyxiation in the stomachs of those that swallowed them, and that the stomach does not digest itself because it is alive. These experiments, it should be remarked, preceded by 20 years the famous studies of digestion made by William Beaumont in the traumatically fistulated stomach of Alexis St. Martin, but for a long time, as a result of Young's early death, no attention was given to his work so original, so ingenious, and of such far-reaching importance (15, Vol. 20, p. 630)
>
> *Young, Thomas* (June 13, 1773-1829) *Physiological Optics*
>
> On 30 May, 1793 [age 19], he read a paper before the Royal Society, in which he attributed the accommodating power of the eye to a muscular structure of the crystalline lens. This was published in the *Philosophical Transactions* of the Society, and led to his election, on 19 June, 1794 [age 21] as a member of the Society.
>
> Young has been justly called "the founder of physiological optics" (TSCHERNING). He was the first to prove conclusively that the accommodation of the eye for vision at different distances was due to change of curvature of the crystalline lens (*Phil. Trans.*, 1793) [age 20] (17, Vol. 21, p. 1309 f.)

In 1910 the great German chemist, Wilhelm Ostwald, attempted to list the 10 most important characteristics of those destined to exhibit extraordinary scientific talent. It is significant that Ostwald placed early development (*Frühreife*) first in his list (45, p. 422). In his study of American Men of Science, J. McKeen Cattell found (1906) that the more distinguished 500 had received both their undergraduate and their graduate degrees at an appreciably younger average age than had the less distinguished 500. A subsequent similar study by Poffenberger yielded corroborative results (47, p. 45).

In the table of contents of his book entitled, *A Collection of English Poems 1660-1800,* Professor Ronald Crane has listed the names of 95 poets in accordance with the date of their first important publication (9, p. viii).

To do this it was necessary for Crane to decide which of the 95 poets' early publications were important and also to assemble dates of publication Tabulation of Crane's findings reveals that 26 per cent of the 95 poets listed by him published their first important work prior to age 22.

It may be recalled in this connection that, although written between his twelfth and twentieth years, Blake's *Poetical Sketches* were not published until Blake was 26 years old If the entire truth were known, it seems likely that, of the 69 poets studied by Crane who *published* their first important work when beyond age 22, some, like William Blake, may have written their poems much earlier.

CONCLUDING OBSERVATIONS

This study makes no mention of the work of living individuals for the following reason When they first appear, discoveries and inventions are often the mere germs of ideas, and it sometimes requires a considerable period of time fully to develop and perfect them In many instances an important discovery has been unused or even totally ignored until the necessary supplementary discoveries have made its utilization practicable, or until a crucial need has forced the issue.

For example, C. F Kettering (32) relates that in 1874 Othmar Zeidler produced the new chemical dichloro diphenyl trichloroethane—DDT for short. But Zeidler saw no use for it, and the formula lay dormant for 65 years. In 1939 Swiss farmers were bothered with an unusual number of insects and, since there was a great shortage of the usual insecticides, DDT was tried with amazingly successful results. During World War II, after much careful experimentation, DDT was found to prevent typhus. Today DDT is our new weapon against both disease and the loss of valuable crops caused annually by some 8,000 different kinds of insects.

The use of DDT for crop protection was greatly facilitated by the invention and perfection of the airplane. Its use as a disease-preventative was hastened by the war emergency and by the development of large-scale production methods. Little did Zeidler know, back in 1874, that he was providing man with one of his most powerful weapons against disease-carrying insects.

The foregoing example illustrates the typical history of a great many of our most important discoveries. The inventor and his contemporaries rarely see or even suspect the potential usefulness (or destructive possibilities) of a new idea. It is sometimes said that the scientist should be held responsible for the social effect of his discoveries and inventions. Such a statement reveals extreme naïvity. Even at this late date, no one can predict the ultimate social effect of, for example, Faraday's electrical discoveries.

Some may have noticed that in the foregoing list only three young women appear This finding is not due to any intentional bias on the part of the present writer but solely to the fact that, in the various sources canvassed, feminine names were few. Time alone will tell whether this situation will continue to hold true in future years. It may be worth noting that the attainment of each of the three women, i e., Jane Austen, Annie Coghill, and Mary Wollstonecraft Shelley, was in a field involving verbal skill.

In this article contributions made by individuals beyond age 21 have been omitted because, if only those made at one or two years beyond age 21 had been included this paper would have had to be of book length. Since, in the preparation of the foregoing list, many fields of endeavor have been ignored entirely, it should be obvious to all that the above is by no means an exhaustive compilation but merely a sample of the important creative work that has been done by gifted fledglings.

With reference to a manuscript submitted to him by the present writer for publication in *Science,* J. McKeen Cattell made the following suggestion. "It might be desirable to make some observations comparing the age of greatest productivity in the different sciences; for example, mathematicians seem to produce their work at an earlier age, whereas, it is considerably later in the case of the natural sciences such as botany and geology" (7)

To the foregoing suggestion the present writer replied that he would prefer to postpone a comparison of the ages of greatest productivity in the various fields of science until he had accumulated more data. Now that much additional data have been assembled, it is this writer's belief that if youths have made outstanding creative contributions in some fields more often than in others, this finding does not reflect variability in the intrinsic difficulty *per se* of the various subject-matter fields, but rather differences in the amount of opportunity that young people have to become familiar with and to deal at first hand with the several subject-matters.

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DEVELOPMENT OF INTERPERSONAL SMILING RESPONSES IN THE PRESCHOOL YEARS*

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A. THE PROBLEM

Literature on smiling, laughing, and other humor responses in infants and young children is limited. Early studies by Washburn (8, 9) determined both that "laughing occurs later chronologically than smiling and is more stereotyped in its form on first occurrence" and that marked and consistent differences can be found in individual infants as to the amount of laughter or crying customarily expressed Washburn lists the types of smiling behavior most characteristic of the various age levels in the first year of life, but concludes that "following its appearance the incidence of smiling and laughing is not a correlate of chronological age, relative rate of mental development, nor physical condition."

Most studies of humor in children deal with children of school age or above. An outstanding study on laughing and smiling in the preschool child is that of Ding and Jersild which reports the behavior of 59 Chinese children ranging in age from two to five years Their conclusion is that there is "a tendency toward higher frequency of laughter and smiling at the 5-year level, low frequency at the 3-year level, and little difference between the 2- and the 4-year olds. The same lack of any noteworthy age relationship is seen in the correlation between laughter frequency and age which gave the low coefficient of 27±0." They further conclude that "laughing and smiling of children from two to five occur predominantly in connection with general physical activity."

The present study aims to determine whether or not definite age trends in both the amount and sources of laughter and smiling exist in the preschool years

B. SUBJECTS AND METHOD

All observations were made in the Guidance Nursery of the Yale Clinic of Child Development while the children were taking part in the regular activities of the nursery group

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Observer for the most part watched this activity from behind one way vision screens and was thus unobserved. Recording was done at approximately the same hour each morning, chiefly during a period of spontaneous play (i.e., not during routines, music, story reading, etc.).

This study was conducted during two consecutive school years, approximately twelve 10- to 15-minute observations being made of each age group each year. A relatively constant group of six to a dozen children were present on each day, but thorough recording could not be done on more than three to seven of them at a time Choice of which children in the group would be observed on any one day was made largely on the basis of which ones were playing fairly close together and near to the observer.

Table 1 indicates the length and number of observations periods, there being for most age levels 25 observations in all.

TABLE 1
LENGTH AND NUMBER OF OBSERVATION PERIODS

Age	No of observations	Length each	No. of children observed
18 mos	12	10-30 mins.	3-6
21 mos.	20	10-20 mins.	3-6
2 yrs	25	10-20 mins.	3-7
2½ yrs	25	10-20 mins	3-7
3 yrs	25	10-15 mins	4-5
3½ yrs	25	10-15 mins	3-6
4 yrs.	25	10-15 mins.	4-7

All instances of smiling and laughing were recorded, with some descriptive detail. Recording was all inclusive (that is of all smiling and laughing behavior) rather than of that accompanying certain kinds of activity Behavior was classified into categories *after* it was recorded. Thus the behavior itself determined the categories used in this study, rather than any pre-established conceptual scheme.

C. DATA

1 *Number of Smiles*

Table 2, which is analyzed in some detail later, indicates the number of smiles (all cases combined) at each age level in relation to each major type of situation, i.e, in relation to child's own activity, in relation to teacher, and in relation to other children. Each of these categories is further subdivided, as the table indicates.

In this master table all 25 daily observations for each age level are grouped together in one total set of scores for the age. Examples of a more detailed presentation which includes daily variations of behavior will be found in

TABLE 2
STIMULI FOR SMILES*

Age	18 mos.	21 mos.	2 yrs.	2½ yrs	3 yrs.	3½ yrs	4 yrs.
Own gross motor	*51*	79	67	98	76	97	97
Own adaptive	8	11	15	19	7	13	7
Own verbal	5	13	14	21	15	39	55
Own imaginative			3	3	12	3	20
Other self activity	3	13	8	11	8	40	48
Total Self	**67**	*116*	*107*	152	118	192	*227*
Social to Teacher	33	*102*	66	108	72	70	43
Verbal-social to T	4	44	*136*	*210*	*192*	175	120
Responds to social from Teacher	3	24	16		8		
Responds verbal-social from teacher	1	10	9	49	52	15	12
Total with Teacher	*41*	**180**	**227**	**367**	**324**	*260*	175
Social to child	6	43	42	85	131	137	101
Verbal-social to child		5	11	55	135	*351*	*356*
Responds to social from child	1	3		1	3	15	16
Responds verbal-social from child		2		5	10	20	8
Activity of child		5	7	7	19	44	33
Other behavior with child				3		24	31
Total with Child	7	58	60	156	*298*	**691**	**646**
One smile every	6 mins	4 mins	4 mins.	2 1/3 mins	2 mins.	1½ mins.	1 1/3 mins.
Daily range in minutes, one every	4-8	3-6	2-6	1-5	1-3	1-2	1-2
Ratio of laughs to smiles	1/10	1/16	1/14	1/12	1/8	1/3	1/3

*To give a clear picture of *daily* variations of behavior, more detailed tables are given for the 3 and 3½ year old groups (see Tables 3-4)

Tables 3 and 4 which give detailed daily data for the 3- and 3½-year age levels respectively

As Table 2 and the detailed age level summaries which follow, show, the *18 monther* smiles most at his own activity; and the type of own activity which amuses him most is his own gross motor. Second most smile provoking are his own social approaches to the teacher.

By *21 months* smiles in relation to the teacher lead, child's own social approach to the teacher being the leading sub-category. Child's own gross motor comes second.

By *two years* the situation remains relatively unchanged in that smiles in relation to the teacher are most frequent; those in relation to child's own activity come second. But the activity in relation to teacher which is most smile provoking has shifted from mere social to "verbal-social" approach to teacher.

At *2½ years* comes a marked shift. Verbal-social approaches to the teacher cause the most smiles; but now behavior in relation to other children comes second. Mere social with other children (not including verbalization) is the stimulus of the most child to child smiling.

At *three years,* as at 2½, verbal-social to teacher produces the most smiles, behavior in relation to some other child the next most. But now it is verbal-social to other children, not social alone, which is the leading sub-category under child-child.

At *3½ years* another conspicuous shift takes place. Now for the first time, child-child behavior evokes more smiles than any other type, and verbal-social to other children is the outstanding sub-type. Next most smiles are caused by child's verbal-social approaches to teacher.

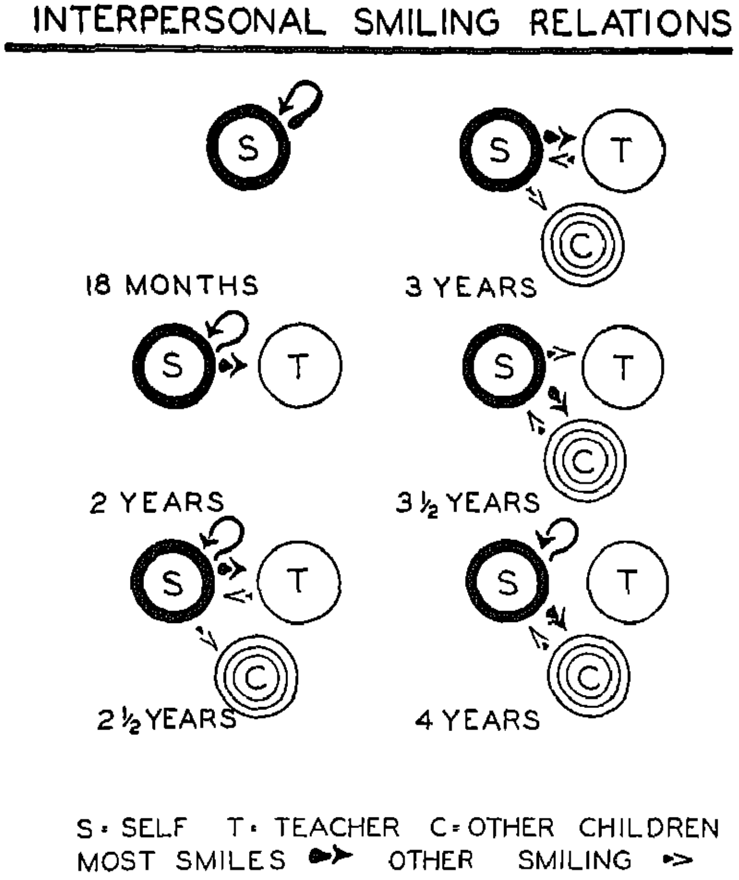
At four, verbal-social to other children still leads, but now another shift has taken place. For the first time, child's behavior in relation to teacher produces the least smiles of any of the kinds of behavior considered here, and the child's own activity, unrelated to others (namely once again his own gross motor behavior) comes second.

Thus the trend is from the child's own gross motor being the most smile-provoking stimulus, through a period when behavior related to the teacher produces the most smiles, to the time (3½ years ff.) when he smiles most at other children. In relation to other people, both teacher and other children, at first mere social approach leads as a smile-producer, later verbal-social approach. Teacher sinks to third place as a smile provoker at four years for the first time.

However, it is noteworthy that at all ages through four years, it is the child's own activity and approaches, regardless of to whom, which cause him to smile more than do his responses to the behavior of others

One further factor brought out by Table 2 is that throughout the age range from 18 months to 2½ years, smiles exceed actual laughter in a ratio of about 10 or more to one, that is 10 smiles to every one laugh By 3½ years this excess of smiles over laughs has dropped to three smiles to one laugh.

Figure 1 indicates the increasing inter-personal complexity of the smiling situation from the time at 18 months when the child alone is involved in smiling situations, to the typical 4-year-old situation which involves child, teacher, and other child or children Only the major inter-personal *smiling* relations are indicated in this figure, not every kind of smiling situation which can be observed at an age


INTERPERSONAL SMILING RELATIONS
S
18 MONTHS
S
T
C
3 YEARS
S
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S
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3 ½ YEARS
S
T
C
2 ½ YEARS
S
T
C
4 YEARS
S = SELF T = TEACHER C = OTHER CHILDREN
MOST SMILES ●➤ OTHER SMILING •>

FIGURE 1

2. *Age Summaries*

a *Eighteen months.* As Table 2 indicates, at this age level there are, in the children observed, 67 smiles while the child is engaged in solitary play, 41 smiles at the teacher, and only seven at other children. Thus *own solitary gross motor activity is the outstanding stimulus for smiling.* Social behavior in relation to teacher comes next, and it is own outgoing approach unaccompanied by verbalization rather than social reaction or verbal-social approach. At first, social approach to teacher in regard to own gross motor activity leads, later child smiles at teacher about other things as well. Social behavior with other children is very limited, as is verbalization connected with smiling or laughing.

For the most part the child is extremely sober-faced. There is little laughing. Smiling is often brief and, as indicated, merely accompanies own gross motor activity. *There is only an average of one smile per child every six minutes.*

Examples

Among the kinds of gross motor activity which induce smiling are:

Falls down on purpose.
Slides down the slide.
Bounces on the slide
Climbs on jungle gym.
Rocks on boat.
Pushes furniture.

Among the things which accompany smiling at teacher are.

Holds out doll to teacher.
Stuffs mouth too full of cracker.
Climbs.
Rocks.
Shows turtle to teacher

b. Twenty-one months. A marked change has taken place in three months *Now activities with teacher, most especially social approach to teacher or verbal-social approach to teacher, lead* as situations in which smiling occurs (180 smiles). Social approach to teacher consists mostly of smiling at her or showing her something, or even in one instance joking with her. (Child coughs, teacher imitates the cough, then child falsely coughs, smiling). Child may also respond to social smile of teacher.

Child's own activity is still a source of much smiling (116 smiles), especially his own gross motor when it is particularly vigorous, as vigorously pushing some object, or rocking high, or riding truck or wagon very fast.

Social to other child is coming in, often in regard to own gross motor or in regard to some particular play object. There are in our group 58 smiles at other children at this age.

There is a little imaginative behavior which may or may not be accompanied by verbalization: pretends to take a bite of something, pretends to pour imaginary milk, pretends to telephone. This pretense may or may not involve actual objects.

There is now one smile per child every four minutes. Thus, obviously, the child is still quite sober-faced.

Examples

Among the kinds of gross motor activity which induce smiling are:

Own jumping, running, sliding down slide, climbing, rocking

Pushing object vigorously.

Riding wagon fast.

Social with teacher:

Just smiles at teacher, points out object in book, shows toy, puts trimming on Christmas tree, smiles accompanying own gross motor.

Joking

Coughs Teacher imitates cough and then child makes believe cough

Imaginative play·

Pretends to take a bite of something and then turns head away; hides and pretends he is not there when someone searches; pretends to telephone with toy phone, pretends to pour milk (out of imaginery milk bottle), pretends to drink milk out of toy cup, hands teacher imaginery milk

Incongruity

Fits self into book shelf

Creeps like the turtle

Laughs at turtle on own shoe

c. Two years At this age as at 21 months, *social activities in relation to teacher definitely lead* as situations in which smiling occurs (227 smiles). Verbal-social with teacher is the leading category. Own gross motor is next and social approach to teacher (without verbalization) comes next. There are 107 smiles at own activity and 60 smiles at other children.

There is now one smile per child every four minutes as against one smile every six minutes at 18 months The child is still quite sober but does not present the stolid and extreme sobriety of 18 months.

Verbal-social approach to teacher is largely about own activity Verbalization is not humorous or even usually imaginative. For the most part it merely calls teacher's attention to the child

A few situations involve a slight amount of what we customarily consider humor Thus one child puts food into his ear instead of into his mouth and smiles at teacher (incongruity).

Social with other children tends to be about joint gross-motor play. Smiling to teacher about own gross motor is more or less taking place of earlier smiling to self about it.

Examples

Actual jokes

Puts food into ear (pretends to) rather than into mouth and smiles at teacher

Offers crayon to child and then playfully snatches it back.

Pulls jacket off wrong-side out and laughs at the incongruity

Own gross motor:

Mostly running and climbing without any object

There is joy at own activity or own prowess or own success.

Showing teacher something or pointing out and naming something to teacher.

Physical attack on other child as poking him in the eye is considered funny, whereas at 18 months it was merely experimental.

Other activity with children:

Grabbing object from child.

Peekaboo game, initiated by one child with another.

Two children repeatedly saying "Hi" to each other with something the same alternation as one gets in peekaboo.

A little imaginative play such as pretending to drink, or to give bear a ride in boat

d Two and a half years. Social situations involving the teacher are now the most smile-producing (367 smiles), the category "verbal-social with teacher" definitely leading. With the 2½ year olds observed during the first year of this study, social approach to teacher is the second leading category, social approach to child third, and own gross motor fourth With those observed in the second year, own gross motor is second and social to teacher third. *There is at this age an average of one smile per child every 2⅓ minutes.*

Own solitary behavior produces 152 smiles. Own gross motor situations which produced smiling were oftenest rather wild activity such as wild jumping, wild throwing, incongruous activity, accidents. In social with teacher, child may smile at teacher just in a friendly manner about some activity, prowess or success, about an accident, about an incongruity, about own imaginative activity

In verbal-social to teacher, the verbalization may merely call attention to own activity or to object child holds, own prowess or product It may be a command to teacher softened by a smile

Verbal-social to child may include silly vocalization, chanting, repeating words, explosive speech, teasing, own incongruous loud voice.

Verbalization: both the words "fun" and "silly" are used.

In social with child, there may be hugs or attacks, and either may be accompanied by a smile. Or child may merely share activity, as rocking, with other child and smile.

Motor combined with verbal, and aggressive attack on child, are new situations which first produce smiles at this age

Incongruity, teasing, joke, silly language all are just beginning to come in at this age and do not appear frequently Examples follow

Examples

Incongruity

Child stands in coat cubby, rides backward, uses incongruously loud voice, says "There's Tommy and there's Tommy" (two Tommies), mentions having chairs for breakfast.

Teasing

Won't let child have object, starts to hand toy to child and then teasingly snatches it away

Accident

Falling down; choking, falling over and getting stuck in chair; falling off bicycle, bumping into rear of other child's bicycle accidentally

Silly language.

"No dumbo! No Gumbo!"
Uses word "Fun"
Says she is making a "silly" turtle

Silly behavior

Child knocks on door of house and other child opens it
They do this repeatedly and both laugh each time

Imagination

Child laughs when he tells teacher first that he's "in town" and then later when he says he is "back home."

Child laughs when teacher says, "We have some galloping horses here this morning"

Child pretends to ride horseback with a broom for a horse

Teacher says goodnight to child who replies, "De moon is shining" and laughs

e *Three years.* At three years, *behavior in relation to the teacher is the leading category* (324 smiles to teacher; 298 to other children, 118 to self). Verbal-social approach to teacher leads. Verbal-social approach to child comes next, and social approach to child is nearly as important *There is an average of one smile per child every two minutes*

Many new things come in here, and trends started at 2½ years are becoming much stronger. Behavior seems now more funny from the adult point of view, no longer just gross motor wild activity or self-expression

Among things noted here for the first time, or for the first time conspicuously are:

> Imaginatively humorous behavior "Have to give fish some dessert," or ringing imaginery bell on bicycle.
>
> Real joking calling child by wrong name; telling child he will be put in jail; putting turtle on boy's *foot*; saying he fell down when it was really the blocks which fell, telling child wrongly what other child's name is; use of word "fooling"
>
> Wild humor situations, mostly gross motor, or *loud* verbalization.
>
> Responding to Teacher's use of word "funny"
>
> Incongruous gross motor: putting ball on head, riding bicycle the wrong way, falling around, putting turtle in truck, walking on knees.
>
> Accidents to self or others or to structure of self or of others.
>
> Own prowess in gross motor or creative activity
>
> Aggression. poking or running into other child.
>
> Beginning of silly language' saying "rock rock" in a silly way, saying "He tickles, he tickles, he tickles," or "Oozy doozy oozy doozy"

Things are becoming more complicated. Child may respond to the teacher and to other children at the same time. Also child verbalizes to teacher about a great many different things, not just calling attention to self or material but remarking on own physical prowess, incongruity, imagination, accident, joke. . . . Also verbal-social is now sometimes to several children at once, not to just one child alone. But even at this age, some frequent smilers seem to be more energetic than humorous.

Table 3 presents complete data for the 3-year age level, showing daily variations in smiling behavior for the 3-year-old age group as a whole. These data have already been summarized in Table 2 but are presented here in full to demonstrate the slight daily variations which occur, as well as the general consistency of trends.

f. Three-and-a-half years. Social with child now definitely leads as a category, verbal-social approach to child being the leading item. Verbal-social to teacher comes next; and social approach to child is third. Smiles at other children occur in 591 instances; at teacher in 260 instances; and in relation to play alone in 192 instances. *There is now an average of one smile per child every 1½ minutes.* Behavior as at three years is funnier from the adult point of view; though sometimes only silly. Many different things cause smiling and laughter:

> Wild and silly gross motor
>
> Vigorous or destructive gross motor.
>
> Unusual gross motor, as standing on head.
>
> Own clowning or that of other child.
>
> Gross motor or adaptive combined with vocal.

Any accident to self or others, aggressive attack on child or excluding child from activity

Any incongruity.

Wrestling, "shooting," wild gestures as if to throw things

Own loud or silly vocalization or repetitive chanting, or such noises as "barking"

Boasting, name calling, or joking. Calling by the *wrong* name

Humor used as a social solvent, as when being chased or if other child refuses a proferred gift

Sheer sociability with other child or other children

Imagination

Own prowess.

Use of word "funny."

Examples

Wild silly gross motor

Just laughs and runs wildly; bats hands around wildly; jumps wildly, throws hat wildly, crashes truck down incline, slams door.

Incongruity

Speaks in incongruously deep voice, puts own foot in truck; pushes carriage crookedly, carriage not where child thinks it is; beats book on own head, sticks foot too far out of chalet, Says "My cracker's so good I want to spit it out", stuffs own mouth too full; knocks house down with his head.

Aggressive

Knocks house down, pushes girl downstairs, knocks down other child's structure, pushes child on the head, hits child, kicks boy's train

Silly verbalization:

"Ladada," "Poopoopoo," "ahahaha," "Hello Mr. Doodoo," "Boo-poopoo," "Well well well"; Chant of "Get in get in get in," joke to teacher about "shoelace" which he considers a funny word; calling other child "Daniel Dumpling" or "Billy Rose"

For this age level, as well as at three years, a complete table of daily variations in smiling behavior is given. As at three years, consistent trends are observed throughout the entire period of observation, but some daily variations occur

g Four years *Behavior with other children, particularly verbal-social approach to other children, now definitely leads* as a source of laughter and smiling (545 smiles and laughs). Own activity, for the first time since 18 months, is the source of more laughter than behavior directed toward the teacher (227 smiles and laughs) In fact teacher-child behavior, *for the first time since 18 months* is the source of less laughter than the child's own activity, stimulating only 175 smiles and laughs This, then, represents again a definite

TABLE 3

THREE YEAR DAILY SUMMARY

Days	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Total
Own gross motor	3		8	4	3	4	4	3	2	1	1	3	4	6	5	5	2		2	3	2		3	1	7	76
Own adaptive					1						1					2		2							1	7
Own verbal			1				3		1				1	4	1			1	1	2						15
Own imaginative					5		2		1														3	1		12
Gross motor + verbal																			1						1	2
Accidents						2						1		1		2										6
																										118
Social to Teacher	2	1	4	3	2	3	4	4	3	1	6	1		4	4	4	1		3	5	1	3	11	1	1	72
Verbal-social to T	14	8		17	6	11	2	5	8	5	7	12	9	5	8	8	6	10	6	14	8	7	4	3	9	192
Responds to social from T	5		2											1												8
Responds verbal-social from T.		2	1	6	7	5		2	1	1	2	10		4	1	2		1		3	1	2	1			52
																										324
Social to child	12	9	11	5	5	5	11	9	2	6	8	4	2	13	4		1	3	3	2	1		4	7	4	131
V-social to child	2	2		2			2	5	13	8	7	10	21	5	5	3	6	2	6	5	5	8	9	4	5	135
Responds to social from child	1							1													1					3
Responds verbal-social from child					1				2	2			2	2			1									10
At activity of child				3	1				2				2	1	2	3	3					1		1		19
																										298

TABLE 4

THREE-AND-A-HALF-YEAR DAILY SUMMARY

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Total
Own gross motor	4	9	2	6	2	7	11	2	3	1	3	3	2	1	4	5	5	3	6	3	2		5	2	6	97
Adaptive + verbal				3					4			2	1		2	2	2			2	1	1	3		2	25
Own adaptive			1								3	1			1	1	1		2	1	1	1				13
Own verbal	4	2		2	1	4	1		3	2				6	1	2		1	2	1		2	1	3	1	39
Own imaginative						1						1			1											3
Incongruity						1					1													1		3
Destruction or accident									6					2								2	1	1		12
																										192
Social to Teacher	7	4	1	3	3	3	2	2	4	1	1	2	1	5	5	1	2	1	2	4	4	3	5	2	2	70
Verbal-social to T	6	10	7	4	7	10	10	9	3	14	7	4	8	7	6	3	10	6	9	3	9	6	9	5	3	175
Responds to verbal-social from T.		3	1	1			1	1					1	1		2	1				1	1	1			15
																										260
Social to child	3	1	1	9	13	7	5	8		2	5	2		5	8	2	3	8	7	11	8	4	9	6	10	137
V-Social to child	*14*	9	*13*	*9*	*16*	*18*	*13*	*30*	*21*	*15*	*16*	*10*	*12*	3	*16*	*7*	*15*	*17*	*12*	1	*20*	*17*	*15*	*18*	*14*	
Responds social from child	1				2			2							1	*9*										15
Responds v-social from child	2		4		4				4					2			1					3				20
Aggressive to child			1					2		1		1														5
Accident to child	3		1	1		3		1								3		1		2		2		2		19
Activity of child			3	2	3		4		6	3		2			4	4	2	3	2		2			2	2	44
																										591

shift in the constantly shifting sources of laughter in the first four years of life. *There is now an average of one smile per child every 1⅓ minutes.* As at 3½ years, very many *different* kinds of behavior are sources of daughter.

Humorous dramatic gross motor
Wild gross motor and verbalization.
Wild silly gross motor.
Dramatization.
Aggressive behavior toward object or child
Accidents, intentional or unintentional.
Accident or failure of self or others
Escaping from teacher or child.
Chasing child.
Clowning or teasing
Imaginative play, alone or with others
Cooperative imaginative play
Silly verbalization
Punning
Name calling or calling by wrong name
Boasting.
Verbal joke.
Verbal-social to child in regard to joint activity.
Verbal to teacher or child.
Exaggeration
Incongruity.
Sex talk or elimination talk
Very loud verbalization.
Joke involving use of word "fool."
Chanting
Verbal to teacher about own prowess.
Destruction.

Examples

Silly language or punning

One boy says, "Gotta have some oars." Other boy replies "Floors?"; "Slang bang whang", "Snip snap snor" instead of "Snip snap snur"; "Oh my stinky old guns", "Bla bla bla", "I'll drop a coconut if you don't watch out", "So what! So so so!"; "Wee da wee da wee da"; "That's my docky"; Boy says he would like to hear "Stinky the sailor", "Wuffy wuffy", "Ha dee ta dee, ha dee ta dee"; "Skate skite skeet"; "Dee dee dee dar"; "Whee, too too too"; Two say to each other "Ding ding ding ding", "Hello ello ello ello"

Elimination talk:

"Toby made wee wee all over the floor" (not true, water was spilled). Calling child a "Wee wee pants."

Name calling or calls wrong name.

Calls Stuart "Jo", says to teacher, "OK, stupid"; says to child "Hello you stinky" or "Hi stink stink you can't get in our boat" or "Lookit the stinky," "Lookit the boney toes," "Hi puffy water"

Joking

Girl on top of gym obviously joking says "Brr! I'm afraid up here!", escaping from teacher as a joke, Daniel calls Rhodes "Jo", pretending to spit through wiring; putting airplane too near teacher's face; pretending to hit another child; saying "It (clay) is going to bite Dicky"; asking teacher, "Are you smokin' a cigar?", Sally saying that she is Connie. Boy asks why and she says "Cause I like to fool" Then boy says, "Hello Connie" in a silly voice.

Teasing

Teases child by not giving him object, holding it just outside his reach, telephones, and tells other child he can't have the telephone

Accident

Child sneezes, child accidentally knocks over blocks; own falling; other child falling, own airplane falling apart, blocks falling, any falling of self, others or object; other child's dropping something, child sitting on toy by mistake

Aggression

Knocking child's building down; pushing child downstairs; throwing sand in child's face; pinching teacher, kicking child

Sex

Boy tells other boy to kiss one of the girls.

Clowning

Child hits self over head and grimaces; child says foolishly to other child, "May I come in?"

Social aggressive gross motor accident or wild foolish gross motor

Any two bump their trucks together over and over, shoot each other, throw blocks, crash train into door; stamp foolishly, shout and jump and laugh at imaginery "snowplow"

Verbal threats.

Boy calls to boy in house, "I'm pouring poison down your chimney."

Joint imaginative play:

Children tell each other where "train" is going; boys tell each other that they are big bad wolves; boys make fast train noises, children knock and then go in and play house, laugh and tell each other about being garage men

D INDIVIDUAL DIFFERENCES

The present method of collecting data does not bring out definitive and clearcut individual differences, but does suggest (agreeing with Washburn's earlier findings) that some children are characteristically more smiling or non-smiling than others and that such differences within a group tend to express themselves consistently. That is, the child who is the most smiling on any one day tends to be the most smiling on any other day, and vice versa Since these data do not appear to warrant detailed presentation, we shall merely give examples of consistency found within any one (yearly) age group.

It will be noted that the overall age trend is for the child to smile more as he grows older and for individual differences to become more conspicuous with increasing age. Thus the range for average number of smiles per 10-minute observation at 18 months is from one smile per child per 10-minute observation for the least smiling child to five smiles per child per 10-minute observation for the most smiling. At four years, the range is from two smiles per 10-minute observation for the least smiling to 11 smiles per 10-minute observation for the most smiling It is probable that these individual differences could be inflected by differences in teachers, some teachers being more provocative of humor than others, but the individual's place would probably remain the same whether the group were more or less smiling.

1. *Eighteen Months Group, Second Year*

Four out of five children show marked consistency of behavior. Group average are: Jill = 4 smiles per observation; Denis = 2+ smiles; Nancy = 2— smiles; Tony = 1, Peter = ½. Jill is the most smiling on three days out of six; and Peter and Tony are the least smiling on every day. Nancy is next to the most on every day when she is present. Only Denis behaves inconsistently.

2 *Three-Year Group, First Year*

In this group all children behave with considerable consistency. Group averages are: Jonathan = 13 smiles per observation period; Rhodes = 10; Susan S. = 8, Susan G = 7; Deena = 7; Daniel = 6, Bruce = 6. Jonathan actually is first five out of seven times; Rhodes is first or second 11 out of 12 times. Susan G. is most or next to most three out of six times; Susan S. first or tied for second three out of four times; Deena is least, next to least or tied for next to least seven out of seven times. Daniel is least six out of 11 times

3. *Three and one-half Year Group, First Year*

All behave with considerable consistency. Group averages are: Bruce = 10 smiles per observation period; Peter = 10, Pravda = 9; Dana = 9; Karin = 8, Carol = 7, Sheila and Heidi each 6, Susie = 3. Bruce is actually most or next to most on four out of six days; Peter most of next to most on five out of seven days. Susie is least on every day that she is present. Others show marked consistency.

E SUMMARY

The present study summarizes 150 observation periods over a two-year interval. Records were made of the spontaneous smiling and laughing behavior of children from 18 months to four years of age, as they took part in the regular play activities of a guidance nursery group From three to seven children were observed on each occasion.

Analysis of data yielded definite age trends not only as to amount of smiling and ratio of smiles to laughs, but also as to stimuli which elicited smiling and as to the person toward whom the smiling and laughing were directed, i.e., to self, to teacher, or to other children.

Thus the amount of smiling increases from one smile per child every six minutes at 18 months to one smile every 1⅓ minutes at four years. Ratio of laughs to smiles increases from one laugh/10 smiles at 18 months to one laugh/3 smiles at four years

Eighteen Months

The child smiles most at his own activity, and the type of own activity which amuses him most is his own gross motor. Second most smile provoking are his own social approaches to the teacher

Twenty-One Months

Smiles in relation to the teacher lead, particularly child's own social approach to teacher, without verbalization Child's own gross motor comes second

Two Years

Smiles in relation to the teacher still lead, but now it is a verbal-social approach to the teacher, not merely a social approach Smiles in relation to child's own activity come second

Two and One-Half Years

Here there is a marked shift. Verbal-social approaches to teacher still lead as smile producers but now behavior in relation to other children (social approach without verbalization) comes second, rather than child's own activity in relation to himself.

Three Years

As at 2½ years, verbal-social to teacher produces the most smiles; but now the second leading behavior is verbal-social in relation to other children, not mere social alone

Three and One-Half Years

Another major shift takes place Now for the first time child-child behavior evokes the most smiles, verbal-social to other children being the outstanding category. Next most smiles are caused by child's verbal-social approaches to teacher.

Four Years

Verbal-social to other children still leads, but now for the first time child's behavior in relation to teacher produces the least smiles of any type of behavior, and child's own activity unrelated to others comes second

Thus the trend is from the child's own gross motor activity as the most smile-provoking stimulus, through a period when behavior related to the teacher produces the most smiles, to the time (3½ years ff.) when he smiles most at other children In relation to other people, both teacher and other children, at first mere social approach leads as a smile-producer, later verbal-social approach. Teacher sinks to third place as a smile provoker at four years for the first time. At all ages through four years it is the child's own activity and approaches, regardless of to whom, which cause him to smile more than do his responses to the behavior of others.

The inter-personal complexity of the smiling situation increases steadily from the time at 18 months when the child alone is chiefly involved in smiling situations till four years when the smiling incident typically involves child and teacher, or child and other child or children.

Findings of this study agree with those of earlier investigations that individual children are characteristically more or less smiling than others within a group, that is that the child in the group who is the most smiling on any day tends to be the most smiling on any other day, and vice versa. The overall trend is for the child to smile and laugh more as he grows older and for individual differences to become more conspicuous with increasing age.

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SOCIAL FACILITATION OF FEEDING BEHAVIOR IN DOGS. II. FEEDING AFTER SATIATION*

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A. INTRODUCTION

A previous paper (5) by the writers has dealt with the problem of group and solitary conditions as factors in feeding behavior in dogs It was found that the increase in the amount eaten in the group situation varied from 3 to 86 per cent for the 10 subjects studied The present study reports on feeding after "satiation."

Previous workers have reported on similar experiments with other species. Fischel (3) has demonstrated stimulation of eating in hens, exhibiting no apparent signs of hunger, upon the sight of another hen eating. Bayer (1) extended these observations and manipulated the size and composition of the groups involved. Harlow (4) studied the social facilitation of feeding in the albino rat and attempted a formulation of the basic mechanisms involved His conclusion was that the essential condition for the occurrence of social facilitation was the presence of rats unrestrained and actively competing with each other for food A series of experiments on rats by Drew (2) yielded some significant information in regard to the conditions under which such facilitation occurs. This writer reports that facilitation of feeding has been found to be the case under certain rather complicated conditions The essential feature apparently is that the conditions arouse a certain state of excitement in the animals Drew also reported that those conditions which will start eating after satiation will prevent it when the animals are hungry.

The major interest of the present experiment was to determine the effects of the introduction of hungry litter-mates on the feeding behavior of a puppy after apparent satiation

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[1] Guest Investigator, Division of Behavior Studies, Jackson Memorial Laboratory, Summer, 1947

[2] The writers should like to express their thanks to Dr J P Scott, Roscoe B Jackson Memorial Laboratory, Bar Harbor, Maine, for his assistance in carrying out the experiment

B. Method and Procedure

The experiment was performed at the Division of Behavior Studies, Roscoe B. Jackson Memorial Laboratory, Bar Harbor, Maine, during the summer of 1947.

1. *Subjects*

The subjects for the experiment were the F1 generation resulting from an Irish Terrier (♀) and a Dachshund (♂) cross. The mother and father were mated at the laboratory, and a litter of eight dogs was born on 21 May, 1947. Two of the eight puppies were destroyed, and three male and three female puppies were kept. The litter was wormed on 26 June, 1947, and each dog was given an injection of liver *B* complex At this time the mother was removed from the litter. Thus the subjects were born under laboratory control, and had contact mainly with the mother during the period preceding the experiment. The dogs were given laboratory identification numbers on 7 July, 1947, as shown in Table 1, together with sex and weight information.

TABLE 1

Number	Sex	Weight (to the nearest ounce)
505	Female	3 lbs., 15 ozs
506	Female	4 lbs., 7 ozs.
507	Female	3 lbs., 9 ozs.
510	Male	4 lbs., 10 ozs.
511	Male	4 lbs., 14 ozs.
512	Male	4 lbs., 3 ozs

2. *Diet and Housing*

The dogs were maintained on the standard laboratory diet. This diet has been described in detail in a previous paper (5). The food, when prepared, had a porridge-like consistency, and was used in the experimental sessions. Water was kept in the cage at all times, except during the test periods. The housing arrangements for these subjects have been described in another report (5). The large cage was located in the nursery wings of the laboratory, and the observations of the subjects could be made while standing in the corridor by means of a special window.

3. *Procedure*

The experiments were performed during the afternoons at approximately 4 P.M., which was about six hours since the morning feeding. The first step involved the weighing of each subject. All weighing was done with a

Fairbanks scale of 35 pound maximum capacity graduated in 0.25 ounces. Estimations were made to the nearest tenth of an ounce.

After each dog had been weighed, one of the group was selected as a subject. The subject was put into his home cage, and the experimenter brought in a large dish of food, the weight of which was known. At this time the stop-watch was started The experimenter observed through the window.

At the end of two minutes, the experimenter entered the cage and weighed the dog and the food The food consumed and the increase in weight of the dog was recorded

The food was again placed before the subject, and the experimenter left the cage and went to the observation window. During the next period, the experimenters recorded the behavior of the subject Eating, defecating, urinating, walking, etc, and the time at which they occurred were recorded.

The next datum to be recorded was the time of the "last lick" at the food The experimenters waited until a period of 15 minutes elapsed since the animal had last eaten or licked the food. This period varied with the subjects studied. When this time period had elapsed, the experimenters weighed the food and the subject. The period of 15 minutes since the last lick was considered to be the period of satiation.

After this weighing period had take place, a single hungry dog was brought into the cage, and both animals were permitted to feed The experimenters observed and recorded the behavior of the two dogs. At the end of two minutes, the experimenters entered the cage, and weighed both of the animals and the food This period was called $N = 2$.

Then, still another hungry dog was brought into the cage, and all three animals were permitted to feed for two minutes. This period has been called $N = 3$ This procedure was continued until a group of six animals was feeding for two minutes. This last period was called $N = 6$.

Thus, the basic data secured for each subject consists of amounts eaten at given time periods, with different members constituting the group.

A repetition of the experiment with three subjects, Nos. 505, 506, and 507, took place several days later in which no additional dogs were introduced. The procedure described above was repeated exactly, including all weighings, handling, and entries on the part of the experimenters.

For the remaining three subjects, Nos 510, 511, and 512, the control period (additional dogs not introduced) took place *before* the experimental trials described above, in order to control any effects of learning. The schedule followed is shown in Table 2.

TABLE 2

Subject	Experimental session	Control session
505	24 July 1947	27 July 1947
506	25 July 1947	28 July 1947
507	26 July 1947	28 July 1947
510	30 July 1947	29 July 1947
511	1 August 1947	31 July 1947
512	6 August 1947	5 August 1947

During the experimental sessions, the order of introduction of hungry subjects was to bring in the dog with the next higher code number until the series was exhausted. Then, the animal with the lowest number was brought in, and the series continued. For example, when 505 was the subject, the order followed was that shown in Table 3.

TABLE 3

Period	Subjects
$N = 2$	505, 506
$N = 3$. .	505, 506, 507..
$N = 6$	505, 506, 507, 510, 511, 512

When 510 was the subject, the order followed was that shown in Table 4.

TABLE 4

Period	Subjects
$N = 2$	510, 511
$N = 3$	510, 511, 512
$N = 4$	510, 511, 512, 505...
$N = 6$	510, 511, 512, 505, 506, 507

C. Results and Discussion

The results for each subject are shown in Table 5-10. Each table shows the data for the control and experimental sessions. For the regular feeding period (two minutes), the amount eaten in ounces is indicated for each session. The time of the "last lick" is indicated, and after the satiation period (15 minutes), the amount eaten since the first two-minute period is shown. The remainder of the data for the control session show the amount eaten in each of the two-minute feeding periods. In the experimental session, however, the data for each period ($N = 2$, $N = 3$) etc. show the amount eaten by the subject during the two-minute feeding period in the presence of other hungry litter-mates. The data are plotted cumulatively for each subject in Figures 1-6.

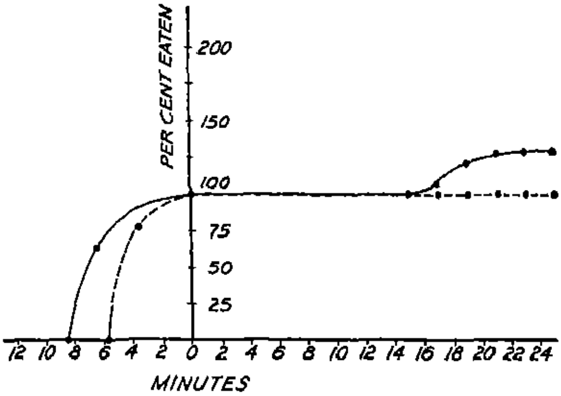

FIGURE 1
SUBJECT 505

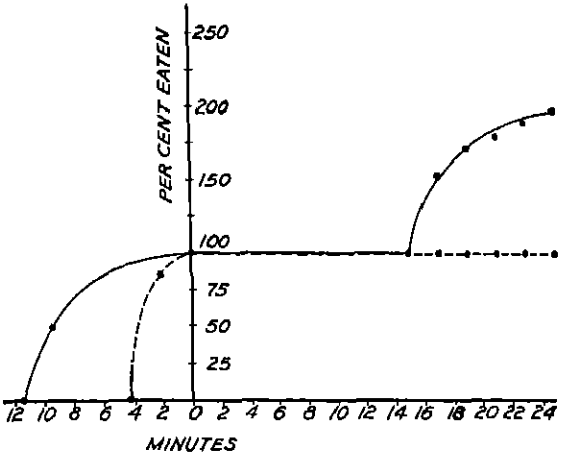

FIGURE 2
SUBJECT 506

In each figure, the results for the experimental period are shown by a solid line, while the results for the control period are shown by a dotted line.

The vertical axis shows per cent eaten, with the amount eaten at the time of the last lick taken as 100 per cent. Thus each point above the 100 per cent level is the per cent eaten above the satiation level for each condition.

The horizontal axis refers to the time relationships involved The time

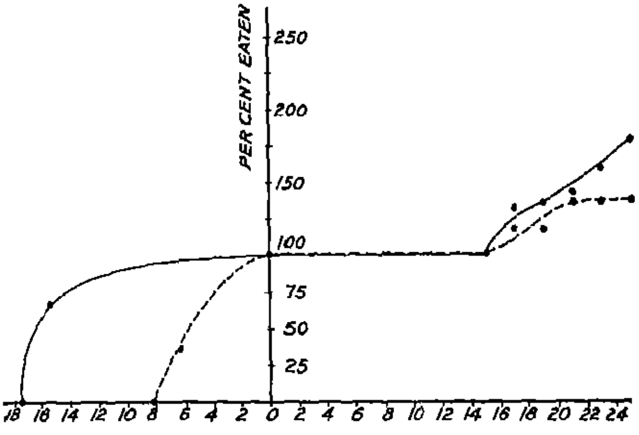

FIGURE 3
Subject 507

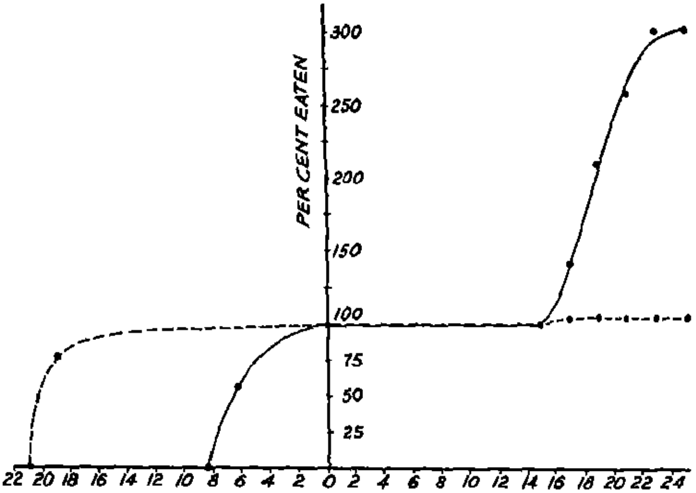

FIGURE 4
Subject 512

of the "last lick" is taken as the zero point, and weighing times are not included on the figure. The scale reads positively in both directions from the zero point.

The right direction indicates the satiation period of 15 minutes, and the

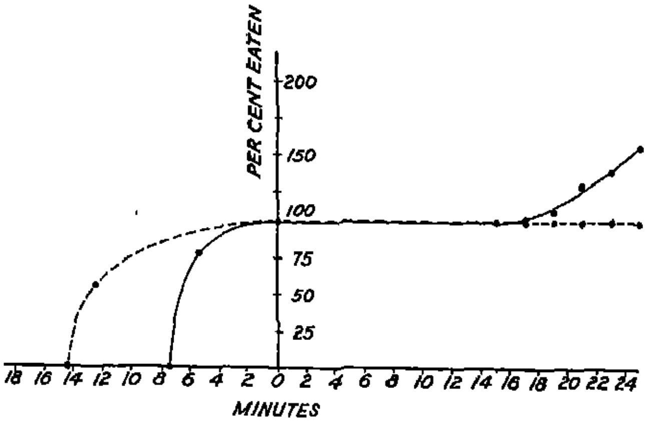

FIGURE 5
Subject 510

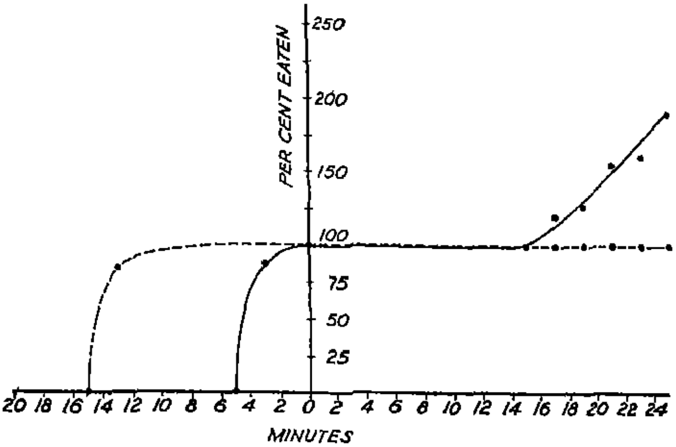

FIGURE 6
Subject 511

$N = 2$, $N = 3$, etc., periods of two minutes for the experimental sessions. For the control period, it should be remembered that after the satiation period, no other subjects were introduced, but comparable data were taken for five successive two-minute periods.

The left direction on the horizontal axis indicates the time in minutes from the start of the period to reach the "last lick." The curve starts at zero amount eaten, and indicates the amount eaten at the end of the first

TABLE 5

SHOWING THE AMOUNT EATEN (AS MEASURED BY BODY WEIGHT CHANGE) BY SUBJECT 505 FOR EACH PART OF THE CONTROL AND EXPERIMENTAL SESSIONS

Control session (27 July, 1947)				Experimental session (24 July, 1947)			
Condition	Time		Amount	Condition	Time		Amount
Regular feeding	2 min	0 sec.	3.8 ozs	Regular feeding	2 min	0 sec	4.6 ozs
Last lick	3	40		Last lick	6	30	
Satiation period	15	0	1.2	Satiation period	15	0	2.6
$N = 1$	2	0	0.0	$N = 2$	2	0	0.5
$N = 1$	2	0	0.0	$N = 3$	2	0	1.1
$N = 1$	2	0	0.0	$N = 4$	2	0	0.5
$N = 1$	2	0	0.0	$N = 5$	2	0	0.9
$N = 1$	2	0	0.0	$N = 6$	2	0	0.0

TABLE 6

SHOWING THE AMOUNT EATEN (AS MEASURED BY BODY WEIGHT CHANGE) BY SUBJECT 506 FOR EACH PART OF THE CONTROL AND EXPERIMENTAL SESSIONS

Control session (28 July, 1947)				Experimental session (25 July, 1947)			
Regular feeding	2 min	0 sec.	4.4 ozs	Regular feeding	2 min	0 sec.	1.9 ozs
Last lick	2	5		Last lick	9	30	
Satiation period	15	0	0.8	Satiation period	15	0	2.0
$N = 1$	2	0	0.0	$N = 2$	2	0	2.1
$N = 1$	2	0	0.0	$N = 3$	2	0	0.7
$N = 1$	2	0	0.0	$N = 4$	2	0	0.3
$N = 1$	2	0	0.0	$N = 5$	2	0	0.4
$N = 1$	2	0	0.0	$N = 6$	2	0	0.3

TABLE 7

SHOWING THE AMOUNT EATEN (AS MEASURED BY BODY WEIGHT CHANGE) BY SUBJECT 507 FOR EACH PART OF THE CONTROL AND EXPERIMENTAL SESSIONS

Control session (28 July, 1947)				Experimental session (26 July, 1947)			
Condition	Time		Amount	Condition	Time		Amount
Regular feeding	2 min	0 sec	0.8 ozs	Regular feeding	2 min	0 sec	4.0 ozs
Last lick	6	20		Last lick	15	30	
Satiation period	15	0	1.4	Satiation period	15	0	2.0
$N = 1$	2	0	0.4	$N = 2$	2	0	1.9
$N = 1$	2	0	0.0	$N = 3$	2	0	0.2
$N = 1$	2	0	0.4	$N = 4$	2	0	0.4
$N = 1$	2	0	0.0	$N = 5$	2	0	1.1
$N = 1$	2	0	0.0	$N = 6$	2	0	1.1

TABLE 8

SHOWING THE AMOUNT EATEN (AS MEASURED BY BODY WEIGHT CHANGE) BY SUBJECT 510 FOR EACH PART OF THE CONTROL AND EXPERIMENTAL SESSIONS

Control session (29 July, 1947)				Experimental session (30 July, 1947)			
Regular feeding	2 min.	0 sec.	4.4 ozs	Regular feeding	2 min	0 sec.	1.4 ozs.
Last lick	18	50		Last lick	6	10	
Satiation periods	15	0	1.3	Satiation period	15	0	1.1
$N = 1$	2	0	0.2	$N = 2$	2	0	1.0
$N = 1$	2	0	0.0	$N = 3$	2	0	1.7
$N = 1$	2	0	0.0	$N = 4$	2	0	1.1
$N = 1$	2	0	0.0	$N = 5$	2	0	1.1
$N = 1$	2	0	0.0	$N = 6$	2	0	0.0

TABLE 9
SHOWING THE AMOUNT EATEN (AS MEASURED BY BODY WEIGHT CHANGE) BY SUBJECT 511 FOR EACH PART OF THE CONTROL AND EXPERIMENTAL SESSIONS

Control session (31 July, 1947)				Experimental session (1 August, 1947)			
Condition	Time		Amount	Condition	Time		Amount
Regular feeding	2 min	0 sec.	3.5 ozs	Regular feeding	2 min	0 sec.	7.7 ozs
Last lick	12	30		Last lick	5	30	
Satiation period	15	0	2.9	Satiation period	15	0	2.4
$N=1$	2	0	0.0	$N=2$	2	0	0.2
$N=1$	2	0	0.0	$N=3$	2	0	0.7
$N=1$	2	0	0.0	$N=4$	2	0	1.6
$N=1$	2	0	0.0	$N=5$	2	0	1.0
$N=1$	2	0	0.0	$N=6$	2	0	1.7

TABLE 10
SHOWING THE AMOUNT EATEN (AS MEASURED BY BODY WEIGHT CHANGE) BY SUBJECT 512 FOR EACH PART OF THE CONTROL AND EXPERIMENTAL SESSIONS

Control session (5 August, 1947)				Experimental session (6 August, 1947)			
Regular feeding	2 min	0 sec.	8.4 ozs	Regular feeding	2 min	0 sec.	5.7 ozs.
Last lick	13	0		Last lick	3	0	
Satiation period	15	0	1.7	Satiation period	15	0	0.9
$N=1$	2	0	0.0	$N=2$	2	0	1.3
$N=1$	2	0	0.0	$N=3$	2	0	0.6
$N=1$	2	0	0.0	$N=4$	2	0	1.7
$N=1$	2	0	0.0	$N=5$	2	0	0.4
$N=1$	2	0	0.0	$N=6$	2	0	2.0

two-minute period (corresponding to the regular feeding period). The amount eaten at the "last lick" is, of course, the amount of food eaten as measured at the end of the satiation period.

For each subject the same trend is seen in the experimental session: a rise in the per cent eaten upon the introduction of other subjects. In the control session, no such increase is present except in the case of No. 507, where some increase is present, and in No. 510 where a minor change is shown.

A tabulation may be made of the period corresponding to $N = 6$ for each subject showing the total per cent eaten as compared with the satiation level (Table 11).

TABLE 11

Subject	Control period*	Experimental period
505	0.00%	*30.41%*
506	0.00	*97.44*
507	36.36	*75.32*
510	*3.51*	200.00
511	*0.00*	51.48
512	*0.00*	90.91

*The italicized figures indicate that this session was the first session.

All of the figures show approximately the same relationship. First, the increase in per cent of food eaten with the introduction of additional hungry litter-mates is clearly evident. In some cases, Nos. 506, 510, and 512, the difference, when compared with the control session, is dramatic. In one case, No. 507, the control period yielded a rise in per cent of food eaten after apparent satiation. The most reasonable explanation of this occurrence seems to be that this subject responded to the presence and activities of the experimenters in much the same way as it did to other hungry dogs. This dog was apparently stimulated to eat after satiation not only by its litter-mates, but also by the experimenters. None of the other subjects demonstrated such a predilection.

The findings presented here demonstrate, under the limited conditions of this experiment, that the presence of other hungry dogs, actively eating, stimulated an apparently satiated animal to further eating.

In the light of several of the studies discussed in the introduction, this study was conducted on young puppies. Marked or clear-cut dominance relationships in the litter were not apparent in the experience of the experimenters.[8]

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[8] The lack of reliable dominance inter-relationships in various test situations for young puppies will be described in another report.

The findings of this experiment suggest that mutual imitation, without demonstrable "envy," active competition, or dominance is an important aspect of social facilitation.

D. SUMMARY

The experiment reports on the effect of the introduction of hungry litter-mates on the feeding behavior of a puppy after apparent satiation. A litter of six Irish Terrier-Dachshund puppies, from the stock of the Roscoe B. Jackson Memorial Laboratory, Bar Harbor, Maine, was used.

The experiment was conducted in two parts: (*a*) with the introduction of single litter-mates who were hungry, and (*b*) without any other dogs present Each subject was permitted to feed until it did not lick the food dish for 15 minutes, before any other dogs were introduced. Both food and subjects were weighed to determine the amount of food eaten during a given period.

A trend was found in all cases for an additional amount to be eaten, when the hungry litter-mates were introduced The increase ranged from 30 to 200 per cent. In the control sessions, an additional amount was eaten by only one subject.

The results are interpreted to suggest, under the conditions of the experiment, that mutual imitation, without demonstrable "envy," active competition, or dominance is a major aspect of social facilitation.

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MEASUREMENT OF VOCABULARIES OF YOUNG BILINGUAL CHILDREN IN BOTH OF THE LANGUAGES USED*

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The study reported here was planned to be only the beginning of a more complete study, but the war intervened before assistance was available and other circumstances have prevented the carrying out of the original intention However, since there have been so few attempts to measure both vocabularies even of a single bilingual child (1), it seems desirable to present the data obtained from this study

The subjects include 30 children of Chinese ancestry resident in Honolulu and ranging in age from 37 to 77 months Parental occupation on the Barr Scale (5) averaged 9 64, which is higher than the average of 7.92 quoted for the general population of the United States but almost exactly that (9 62) of the larger group of such children used in our previous study of bilingual children (4) Vocabulary was measured by the use of the Smith Vocabulary Test (3). The test was given in English one day and in Chinese on another by an examiner conversant with both languages and herself of Chinese ancestry. Where an exact equivalent of the English word did not occur in the Chinese translation of the test, the nearest substitute was used. As the commonest Chinese name of an article pictured or action described was always accepted, which is not always true in the English form of the test, the Chinese form was probably easier, although all but one of our best subjects scored lower on the Chinese form However, this is what would be expected, since our previous study had shown that children of Chinese ancestry in Honolulu preferred to use English rather than Chinese since 80 per cent of the words used in the conversations gathered from them were English.

Comparison with average scores made on the test by monolingual children was made, for which purpose new norms were calculated, 62 cases being added to the original group of children. These new cases were obtained from the same sources as those in the original study had been and were tested not long after. These new norms are shown in Table 1.

When the bilingual children are grouped at four age levels (see Table 2),

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[1] Thanks are due to Miss Goldie Li for the collection of the data

TABLE 1

NEW NORMS FOR THE SMITH VOCABULARY TEST

Age in years	Number of cases	Average *IQ*	Estimated Number of words known
3	22	107	865
3½	30	106	1,230
4	30	109	1,545
4½	43	108	1,836
5	32	109	2,072
5½	34	109	2,350
6	22	109	2,505
6½	6	105	2,533

TABLE 2

AVERAGE VOCABULARIES OF BILINGUAL CHILDREN OF CHINESE ANCESTRY AT DIFFERENT AGE LEVELS

Average age in years	Number of children	Estimated number of words known			Per cent of norm reached in			
		English	Chinese	Both languages	Total English	Total Chinese	Both languages	Different words
3.55	6	473	260	200	55	37	92	76
4.59	12	737	340	238	53	31	85	72
5.67	6	993	623	550	66	50	115	92
6.00	6	957	590	487	58	43	101	81

their average vocabularies in either language are far below the English vocabularies of the monoglots. The average per cent of the norm reached ranges at the different age levels, from 53 per cent to 66 per cent in English vocabulary and from 31 per cent to 50 per cent in Chinese. Even when both vocabularies are added together, the younger children fail to attain the monoglots' average in English alone, the six-year-olds just reach it, only the five-and-a-half-year-olds exceed it However, if the words known in both languages are counted only once, no group attains the norm, but reach only from 72 per cent to 92 per cent of it.

Since the range of vocabulary scores was large and the number of children at each age level so few, a further comparison was made for each child separately (see Table 3) For this comparison a norm was calculated by interpolation for each child whose age did not agree exactly with one of the age levels for which norms had been determined. For each child the differences between his estimated norm and his total vocabulary scores for English alone, Chinese alone, for the two languages added together, and for the two with words of duplicate meaning counted but once were found.

TABLE 3

Scores Made by Individuals on Vocabulary Test Compared With Adjusted Norms

			Known in					Differences from norms			
	Sex	Age in months	English only	Chinese only	Both languages	Total English	Total Chinese	Total English	Total Chinese	Total vocabularies	Minus duplicates
G C	G	37	500	220	260	760	480	— 166	— 446	+314	+ 54
D A	G	37	600	240	180	780	420	— 146	— 506	+274	+ 94
E.A	G	39	540	340	160	700	500	— 348	— 548	+152	— 8
E.C.	B	44	500	140	100	600	240	— 735	—1,095	—495	—595
A H	G	45	340	360	300	640	660	— 748	— 728	— 88	—388
K.C	B	47	360	260	200	560	460	— 932	—1,032	—472	—672
B A	G	49	620	340	220	840	560	— 754	—1,034	—194	—414
M C	G	51	600	420	360	960	780	— 730	— 910	+ 50	—310
A C.	B	52	660	380	280	940	660	— 799	—1,079	—139	—419
S G	G	52	840	300	140	980	440	— 759	—1,299	—319	—459
S C	G	53	880	380	300	1,180	680	— 608	—1,108	+ 72	—228
L G	B	53	680	360	280	960	640	— 828	—1,148	—188	—468
L Y	B	54	820	340	280	1,100	620	— 736	—1,216	—116	—396
I C	B	54	840	380	260	1,100	640	— 736	—1,196	— 96	—356
A.L.	B	55	700	340	200	900	540	— 975	—1,335	—435	—635
Y L	B	57	660	240	160	820	400	—1,135	—1,555	—735	—895
D Y	B	58	760	320	180	940	540	—1,054	—1,494	—554	—734
M.C.	G	59	780	280	200	980	480	—1,053	—1,553	—573	—773
T C	B	64	1,120	680	640	1,760	1,320	— 498	— 938	+822	+182
F C	B	65	1,100	800	600	1,700	1,400	— 604	— 904	+796	+196
B P	G	66	640	460	420	1,060	880	—1,290	—1,470	—410	—830
V G	G	67	980	520	480	1,460	1.000	— 916	—1,376	+ 84	—396
H.P	G	68	1,120	440	400	1,520	840	— 882	—1,562	— 42	—442
G L	B	68	1,000	840	760	1,760	1,600	— 642	— 802	+958	+198
C C	B	69	920	500	380	1,300	880	—1,128	—1,548	—248	—628
A H	G	70	980	500	400	1,380	900	—1,074	—1,554	—174	—574
E H	B	71	920	720	580	1,500	1,300	— 980	—1,180	+320	—260
L H	G	72	980	680	600	1,580	1,280	— 925	—1,225	+355	—245
N L	G	73	880	560	440	1,320	1,000	—1,199	—1,519	—199	—639
R L	B	77	1,060	580	520	1,580	1,100	— 949	—1,429	+151	—369
			Averages								
All boys		59.2	807	459	361	1,168	820	— 849	—1,196	— 35	—323
All girls		55 9	752	403	324	1,076	727	— 773	—1,123	— 47	—371
All thirty		57 5	780	431	342	1,122	773	— 811	—1,159	— 38	—380

The averages of these four counts give in every case minus differences for all the children, for all the boys or for all the girls. For one language only, none of the children come near the norm for monoglots of the same age, the per cent of norm reached being 58 per cent in English and 40 per cent in Chinese When both languages are added together, the scores on the average are almost as high as the estimated norms; but not when words of duplicate meaning are counted but once, when on the average 80 per cent of the estimated norms is attained.

Although the average child does not attain expectancy even when both vocabularies are counted, there are some that do. In five cases, the two youngest girls and the three boys in the five-and-a-half-year-old group, the score in both languages minus duplicates exceed the estimated norms by an average of 144.8 words. Seven additional children exceed their estimated norms when words of duplicate meaning were counted twice; the average for all 12 being 306 words.

Another study by Elsie Ching Motoyama (2) found even lower vocabularies for children of Chinese ancestry. In that study, 50 such children were tested by the Smith Vocabulary Test before and after a year of kindergarten attendance At entrance, when they averaged 64.7 months in age, their English vocabularies averaged only 910 words, barely 40 per cent of the norm, and a year later at an average age of 77.3 months, although they had enjoyed a year's attendance at kindergartens where only English was spoken, their average vocabulary was 1,560 words or only 62 per cent of the norm. This average is almost exactly that of our five-and-a-half-year-olds who are evidently a superior group, for they are superior also to our six-year-olds excelling them by words known in each language by an average of 100 words and by words known in both by 63 words. Mrs. Motoyama's cases came from a lower occupational level approximating that of the general population in the United States She found boys superior to girls in English vocabulary, the average vocabularies at the first test being for boys 990 words, for girls 810, and at the second test, 1,680 and 1,400 words respectively. Our older boys too excelled the girls, not only in English but also in Chinese vocabularies; but the nine younger girls averaged English vocabularies of 869 words, almost equal to the average of 880 words made by the nine younger boys, and surpassed them by 34 words in Chinese vocabulary and by 22 in words known in both languages. Of the total vocabulary exclusive of duplicates, for all 30 children, words known in both languages comprised but 21 per cent, those known in Chinese only 28 per cent, and those in English only 51 per cent. There was almost no difference in these percentages for boys and girls.

Discussion

These data, although based on too few cases for proof, indicate as did our former study that a bilingual child is seldom sufficiently advanced by six years of age in either of the two languages he speaks to be as ready for school instruction as is the average monolingual child; since he knows so much fewer words and, as our previous study showed, uses them more incorrectly. Nor does he usually have a word for as many concepts as does the monoglot, for when words known in both languages are not counted twice, his combined vocabularies do not often equal that of the average monolingual child Although if the two total vocabularies are added together and words of duplicate meaning are not subtracted, 40 per cent of these cases surpass the norms, this does not show much advantage in bilingualism at this age, since a name for each of a larger number of concepts is more advantageous than two names for many of a smaller number of concepts.

However, if a child lives in a bilingual environment or in one where the official language and that of his home differs, he does benefit to some degree in his ability to converse, even if inadequately, in both languages It would however appear unwise to unnecessarily start children, as young as these studied, in a second language, unless they are of above average in linguistic ability, which cannot well be determined before some progress has been made with the first language.

Summary and Conclusions

1 This study describes an attempt to measure the vocabularies in both languages used by a group of 30 bilingual children who knew both Chinese and English words

2. In either language the group was found to have below average-sized vocabularies for children of their age.

3. When the vocabularies of the two languages are added together two-fifths of the children exceeded the norms for monolingual children, but when words of duplicate meaning were subtracted only one-sixth of them did

4. It is suggested that only the superior bilingual child is capable of attaining the vocabulary norms of monoglots and that a name for a large number of concepts is more desirable than two names for many of a smaller number of concepts

5. It would seem unwise to start any but children of superior linguistic ability at a second language unnecessarily during the preschool years

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A COMPARATIVE STUDY OF FIGURE-GROUND DISCRIMINATION IN PRESCHOOL CHILDREN AND ADULTS*

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A. INTRODUCTION

The hypothesis which these studies test is that (*a*) the preschool child sees figure and ground differently than does the adult, and that (*b*) perception of ground by the child resembles more that of the adult than does perception of figure. The Gestalt theory of figure-ground perception contents itself only with making the obvious distinction between the quality of figure and the quality of ground Koffka (5) maintains "Ground and figure, since they are phenomenally inseparable, must arise together A part of the world is thus differentiated and appears as a quality, whereas whatever remains may still appear as a uniform ground, though in reality it is extremely complex" (p. 153) Again, "Generally stated, from an unlimited and ill defined background there has arisen a limited and somewhat definite phenomenon, a quality" (p. 145) The stages leading to the adult distinction between figure and ground have never been adequately investigated, with the result that there is an implicit assumption of equivalence of perception of figure and ground at all ages.

The underlying purpose of this study was to fill up certain of the lacunae in investigations on ages prior to the adult A preliminary experiment to test the initial hypothesis, that the preschool child perceived figure and ground differently than did the adult, was carried out, using a test-card exposed for 0.5 seconds, to 38 preschool children and 7 adults. Results indicated that the hypothesis was tenable.

The following developmental sequence was hypothesized. Since by its very nature ground is perceived as vague and ill defined, it is hardly probable that much change in its perception in the direction of better articulation takes place In comparison to what it will eventually be in the adult, the child's perception of ground is relatively static and mature. Since

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figure, however, may be more or less well articulated even in the adult, according to the subject's condition and the conditions of presentation, any developmental changes probably are reflected in figure. In comparison to the adult, the child's perception of figure is more diffuse, more poorly articulated, less cohesive. Hence, in the two stages compared ground perception should be alike, figure perception different.

The problem of figure-ground perception is basic to that of the development of visual perception in the child, and even to the problem of the child's learning. An object which is discriminated from other objects becomes a figure to the ground of the remaining objects. Goldstein (3) has called the figure-ground relationship the most basic problem of development. Since Rubin's monumental work (7) the problem has been a major one in the studies of the Gestalt school of psychology. Although work has been done in this country and in Great Britain in the dynamics of figure and ground (Wever, 9; Fry and Robertson, 2; and in Great Britain Harrower, 4a and 4b; and Craik and Zangwill, 1) almost nothing has been done on the problem of figure-ground discrimination as it is related to the development of children. Most recently Werner and Strauss (8) have studied differences in figure-ground perception between feebleminded and normal children.

The method of investigation in the main experiment was by presentation to the subject of a test card which was then removed, the subject being then asked to pick the card he had just seen out of several choice cards laid before him. The experimental variables were the density of the ground (defined as the distance separating the lines of the background); and size of figure The choice cards represented, in any one series, varying distances of ground lines for a constant figure; or else varying sizes of figure for a constant ground To force the subject to indicate where he would tend to locate his percept of the test card along the scale of varying figures sizes and ground lines, and not merely to select the correct choice card, the test card was not included among the choice cards.[2]

Thus the subject was faced with an absolute choice problem. Theoretically, if he perceived all or several of the choice cards as equally like the test cards, he should choose an equal number of times every card in the series. If he perceived the test card as more like a particular one of the choice cards, he would tend to pick that card.

If one choice card were chosen significantly more times than another, it could be said that the subject perceived the chosen card as being similar to the test card (or to put the matter in its reverse form, the test card as being like the choice card) and hence, since the choice cards represented differences in degree from the original, we could tell how far and in what direction the child's perception deviated from the arbitrary norm of the test card and from the adult's choices. The degree to which the child's choices approximated those of the adult would be a measure of the degree to which he perceived figure and ground as more or less like the adult.

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[2] Suggested by Dr Heinz Werner

B. Materials and Subjects

The materials for the second experiment consisted of eight series of cards. Series 1, 2, 3, and 4 each consisted of seven cards in which the ground was not varied within the individual series but varied from series to series (see Figure 1). (Series 1 had left-right diagonal lines, Series 2 had right-left diagonal lines, Series 3 had vertical lines, and Series 4 had horizontal lines. All ground lines were drawn 0.5 cm. apart.) The size of the figure, however, varied within each series ranging from 9 cm. to 3 cm. in length, (*A*, 9 cm., *B*, 8 cm., *C*, 7 cm., Testcard 6 cm., *D*, 5 cm., *E*, 4 cm.; *F*, 3 cm.: see corresponding scale, values, next section). Series 5, 6, 7, and 8 consisted of seven cards each in which the nonvarying material was the size of the figure, approximately 6 cm. in length (see Figure 2). The vary-

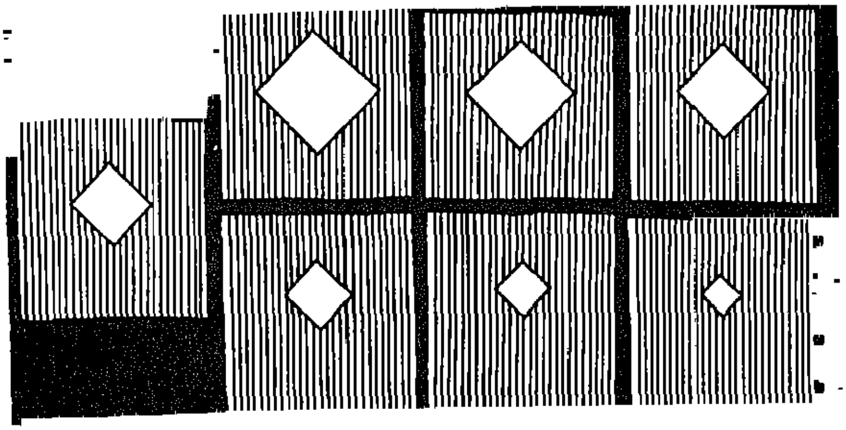

FIGURE 1

Example of figure series (ground constant, figure varied) left to right Test Card

Card Card Card
A *B* *C*
D *E* *F*

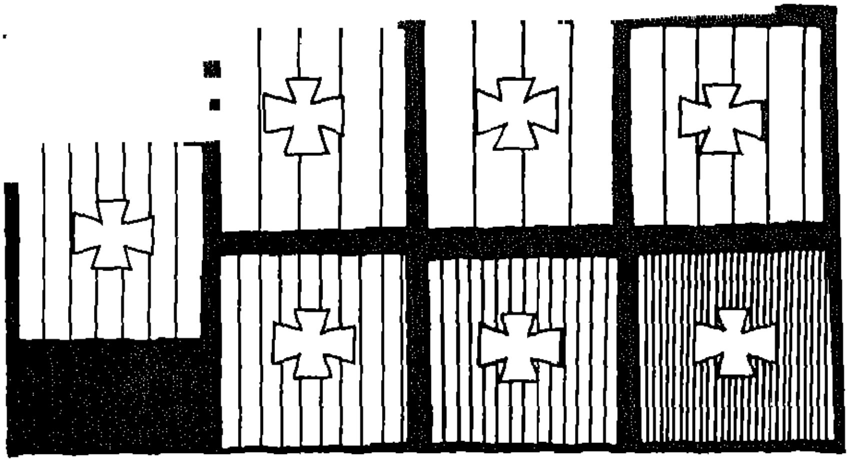

FIGURE 2
Example of ground series (figure constant, ground varied) left to right: Test Card

ing material was the spacing of the lines of the ground. Series 5 had left-right diagonal lines, Series 6 had vertical lines, Series 7 had horizontal lines, Series 8 had right-left diagonal lines. The lines of each card within the series ranged from 3.5 cm. apart to 0.5 cm apart, (*A,* 3.5 cm.; *B,* 3.0 cm ; *C,* 2.5 cm., Testcard 2.0 cm.; *D,* 1 5 cm., *E,* 1.0 cm.; *F,* 0.5 cm.' see corresponding scale values next section). Use of different arrangements of lines was to cancel out the possible influence of the direction of the lines. The shape of the figures in all the series was different.

The definition of ground density was the objective distance separating one line from the other, the closer the lines were together the denser was the ground The fact that only one variable was present within each series meant that the child could choose only on the basis of size of figure or the density of the ground.

A preliminary practice series consisted of four cards: 1P: a rectangular figure 6 cm. by 3.5 cm. on a ground of two horizontal lines drawn 3.5 cm apart, 2P: a rectangular figure 4 cm. by 3 cm. on a ground of two horizontal lines drawn 3.0 cm. apart, 3P: a rectangular figure 3 cm. by 2 5 cm. on a ground of two horizontal lines drawn 2.5 cm. apart; 4P: a rectangular figure 4 cm. by 3 cm. without any ground at all.

The subjects were 20 adults and 23 children The adults were graduate students of the Iowa Child Welfare Research Station and the Dept. of Psychology of the State University of Iowa. No *IQ's* were available for these subjects The child subjects were obtained from the Iowa Child Welfare Research Station preschool laboratories. Chronological ages ranged from three years eight months to five years eight months with the median age at four years eleven months Thirteen of the subjects had been used in the first experiment, 10 had not Since *IQ*'s are not available for the new subjects, these are not reported here and no correlation was made between test score and mental age.

C. Procedure

The preschool children were brought to the experimental room and seated at a child's table opposite the experimenter. The table was in the approximate center of the room removed from the sunlight; overhead lighting was supplied from a 100 watt daylight bulb No attempt was made to secure additional illumination

A white triangle was placed on the table approximately 10 cm in front of the subject. The focussing point of the triangle served to fixate the child's eyes upon the area in which the test card was to be exposed, a procedure necessitated by the distractibility and restlessness of the preschool child The following instructions were given

> I am going to show you some pictures, but I am going to show them very fast. I am going to show them to you right over here (pointing to the triangle). I want you to watch the little white triangle very carefully because afterwards I shall ask you to remember which picture I showed you. Do you understand?

To demonstrate the experimental procedure and to ascertain if possible the initial level of the child's performance, he was shown the Preliminary practice series of four cards. The child was given a set to respond by warning him to keep his eyes on the triangle, then the practice test card (which for purposes of demonstration was any one of the four) was exposed for about 0 5 seconds by placing it directly on top of the fixation card The subject was asked if he had seen the card, and if he replied in the negative, the card was re-exposed Such failures to perceive occurred only three or four times in the course of the experiment. Immediately afterward all the cards were placed in random order in two rows, upon the table The child was told, "Look at all the cards carefully and then point to the one which you have just seen."

Although differences in exposure time resulting from the inevitable variability of the arm movement were present, these were believed to be minimal. The arm movement had been practiced prior to the experiment until it had become to all intents and purposes standardized. Time intervals of exposure were clocked with a stopwatch to secure an index of variability.

No set number of trials were given with the practice series. Although many children in the course of the two or three trials usually given made at least one correct discrimination, some did not; but it was assumed that failures were a function of the child's temporary threshold of response rather than inability to understand the instructions, since these children generally made at least one correct choice on the experimental series proper and many made more.

Following the preliminary practice series the eight experimental series were run in exactly the same manner, although the test card was not included among the choice cards. All responses were applauded by "fine" or else by a noncommittal sound. Every effort was made to prevent the child from learning whether or not his choice was correct; motivation was given by telling the child that he was doing very well indeed. The experimenter was also careful not to direct the attention of the child to the choice card by glance or gesture.

The order in which the eight sets of cards were presented in relation to every other set varied according to chance; the nine sets were randomized by the experimenter before presentation to each child. Thus, for one child the order of the eight series might be 1, 2, 3, 4, 5, 6, 7, 8; for another, 8, 7, 6, 5, 4, 3, 2, 1, for another, 4, 5, 6, 8, 7, 1, 2, 3. It was believed that randomization would cancel out any potential serial position effects. The choice cards within each set of cards were later randomized before being placed in front of the child.

Identical instructions were given to the adult group as were given to the preschool subjects. However, the adults were informed that what was required was the choice of a card *most* like the one they had seen and that there were no right or wrong choices in this test. This was necessitated by the fact that the adult subjects immediately realized that the test card was not being presented along with the choice cards.

It was originally intended that the child should be instructed also to choose a card "most like" the test card, but this instruction was discarded because it introduced too great complexity into the experimental situation for the child Instead, although the test card was not included among the choice cards, the child was asked to point to the one he had just seen, a deception which it is believed did not materially affect the results.

D. RESULTS

1. *Figure Choices for Adult Group*

Scale values of $A = 1$, $B = 2$, $C = 3$, $D = 5$, $E = 6$, $F = 7$, corresponding to the size of the figure and the ground, such that A had the largest figure and the least dense ground, and F the smallest figure and the densest ground, were applied to the several cards of the sight series of *cards used in the main experiment proper.*

TABLE 1
FIGURE CHOICES FOR ADULTS

Card	Total choice	Mean choice	Standard deviation
A	0	0	—
B	10	0.5	0.59
C	24	1.2	0.67
D	39	1.95	0.74
E	6	0.3	0.46
F	0	0	—
ABC	34	1.7	0.95
DEF	45	2.25	0.94

T-value 0.1 of the difference between the derived mean and the theoretical mean
Significance $<$ 5 per cent level.
$N = 20$

All the Type A cards of the series in which figure alone was varied were considered equivalent and grouped together, all the Type B cards were grouped together, etc., each individual figure choice was multiplied by the scale values given above to give the subject a total score $= (x)$. A total scale score for the group was found by adding individual scores (sum of the x's). A t-test was used for the significance of the difference between the mean (M) of these scores and the theoretical mean (MT). The theoretical mean was the score the subject would have made if the test card had been presented and the subject had chosen correctly each time (See Table 1).

Using the t-formula, $$\mathrm{T} = \frac{M - MT}{\sqrt{\dfrac{\Sigma x^2 - M(\Sigma x^2)}{N(N-1)}}} \tag{6}$$

n-1 degrees of freedom, one gets a t- value of 0.1 for the difference between the obtained (4.0) mean and the theoretical (4.0) mean which is not significant at the 5 per cent level of confidence. Hence the adult tends to see the test card as being equally like Cards C and D. The tendency to see choice cards with small figures as more like the test card is not statistically reliable.

2. *Ground Choices for Adults*

Using the same procedure of assigning scale values to individual choices and deriving a mean (4.6) which is then compared with the theoretical mean of 4.0, one gets a *t*-value of 2.7 for the total group which is significant for statistical reliability at the 2 per cent level of confidence (See Table 2).

TABLE 2
GROUND CHOICES FOR ADULTS

Card	Total choice	Mean choice	Standard deviation
A	2	0.1	—
B	1	0.05	—
C	22	1.1	0.99
D	35	1.75	1.04
E	17	0.85	0.89
F	2	0.1	—
ABC	25	1.25	1.04
DEF	54	2.7	1.10

T-value: 2.7 of the difference between the derived mean and the theoretical mean.
Significance: $>$ 2 per cent level
$N = 20$

Thus one may say that adults perceive the test card for ground as more like strongly dense ground than weak and hence as stronger than it objectively is.

3. *Figure Choices for Children*

The same procedure of assigning scale values to all figure choices and then comparing the mean of these choices with the theoretical mean was followed

The *t*-value of the difference between the theoretical (4.0) and the derived mean for the series (3.3) in which figure was varied, using the above formula, is 3.17, 22 degrees of freedom, which is significant at the 1 per cent

TABLE 3
FIGURE CHOICES FOR CHILDREN

Card	Total choice	Mean choice	Standard deviation
A	17	0.74	0.85
B	23	1.0	0.83
C	22	0.90	1.08
D	15	0.67	1.05
E	8	0.35	0.56
F	7	0.30	0.68
ABC	62	2.7	1.196
DEF	30	1.3	1.27

T-value 3.17 of the difference between the derived mean and the theoretical mean.
Significance: $>$ 1 per cent level.
$N = 23$

level of confidence. Hence we may say that children tend reliably to see the choice cards with large figure as more like the test card than they do choice cards with small figures (See Table 3).

4. *Ground Choices for Children*

The t-value of the significance of the deviation of the actual mean (4.7) from the theoretical mean (4.0) is 2.06, which lacks significance at the 5 per cent level of confidence (5 per cent = 2.07). Hence children, in contrast to adults, do not tend as reliably to see choice cards with strongly dense ground as more similar to the test card than they do weak densities (Table 4).

TABLE 4
GROUND CHOICES FOR CHILDREN

Card	Total choice	Mean choice	Standard deviation
A	8	0.35	0.56
B	16	0.69	1.07
C	6	0.26	0.04
D	23	1.0	0.88
E	18	0.78	0.93
F	21	0.91	0.83
ABC	30	1.3	1.26
DEF	62	2.7	1.26

T-value 2.06 of the difference between the derived mean and the theoretical mean
Significance < 5 per cent level
$N = 23$

E. DISCUSSION

In our experiment the child was forced to select a choice card which the test card most resembled. Consequently, if the test card for ground was perceived as neither stronger or weaker in density than the objective density of its construction, the subjects choices would tend to cluster about the theoretical mean value represented by the value of the test card. Fifty per cent of the choices would be Card *C*, 50 per cent would be Card *D*. Selection of a choice card of strong ground density (*DEF*: lines close together) would imply perception of the test card as strongly dense, selection of a choice card of weak ground density (*ABC*: lines far apart) would imply perception of the test card as of weak ground density. On the other hand, consistent selection of a choice card with a large figure would imply perception of the test card as of larger figure than it was objectively; consistent selection of a choice card with small figure would imply perception of the test card as of smaller figure than it objectively was.

It is possible, but hardly tenable, that when the choice card was displayed, the subject perceived it as being (without comparison to the test card) weaker or stronger in ground density and larger or smaller in figure than it objectively was; and that consequently the entire figure and ground scale shifted one or two steps up or down. The fact that Card *B* in the figure scale for children was chosen most often might then be explained on the basis that the figure of Card *B* seemed to the child subject not to be 8 cm. in length but actually 6 cm. However, since child and adult choices do not coincide we should then be faced with the problem of why the optical illusion operates in one manner for children and in another for adults. The difficulties implied in such an interpretation are obvious.

In the case of the ground scale we may infer that, although there is a tendency for the child to see the test card as being more like strong densities than weak, it is not as consistent as is the adult tendency, as measured by lack of significance at the 5 per cent level of confidence. In this he differs from the adult, who gives far more reliable results (at the 2 per cent level of confidence). There are two possible explanations for this: either the same tendency is present to equal degree in both adults and children, but that there was a larger sampling error for children or children of this age are inherently less reliable than are adults; or else even in the case of ground perception some slight maturation still takes place Considering that the *t*-value for ground differences for children misses significance by only 0 01 (a *t*-value of 2.07 is significant at the 5 per cent level) the former explanation is probably more correct: there is really no major developmental sequence for ground perception.

In the case of figure it is possible to infer that the test card is perceived by the child as being larger than it objectively is. The adult, on the contrary, has a tendency to see the test figure as being smaller than it objectively is, but this tendency does not meet the criterion of statistical reliability at the 5 per cent level. Ignoring the lack of reliability temporarily, we see that the directions of deviation for the figure scale from the arbitrary norm of the test card are opposed Since there are no real differences in ground perception between children and adults, the degree of difference between child and adult is greater in the case of figure than in the case of ground. Thus the hypothesis that perception of ground should show more similarity to that of the adult than should perception of figure is borne out by the results

One might well ask why the adult tends to see figure as smaller than it actually is. If there must be a developmental sequence for figure perception, why should it not be from small figure to large, since large figures are more easily perceived than are small. Why is this reversed for children?

There is a tendency for any individual to perceive figure as cohesive as it can be, as well articulated as it can be, in the sense that it stands well out from the background. This follows from the law of Pragnanz A large figure, however, does not stand out well from the background by reason of its very largeness True, it impresses itself upon the eye, but only when it is considered without reference to the ground. When one is considered in relation to the other, the larger the figure it is, the more it tends to be seen as both figure and ground In other words, the larger it is the more it tends to swallow up the ground, till it becomes itself practically ground Consider a 9-inch square of black paper upon an 18-inch square of white background. The black square stands out well, but when the black square is enlarged to 16 inches upon the same background of 18 inches, the complete stimulus is hardly seen as black figure upon white ground, but as practically all black.

In the figure scale the adults were faced with a figure-ground problem, although the basis of choice was figure, and we may assume that their attention was concentrated upon both figure and ground The child's attention in the figure scale was directed to figure only—consequently he chose the most articulated figure he saw; but the most articulated figure and ground presupposes a figure which is smaller than the ground.

It is perhaps now possible to say that the child's perception of figure as being larger than it objectively is, is a more primitive type of perception than is the adult's, since the perception of one object is necessarily more primitive than the perception of two, or the relationship between them.

The fact that even in very young children perception seems well established argues again for the possibility that ground perception is a more primitive mode of reaction than is figure perception Koffka (5b, p 184) has stated "The figure depends for its characteristics upon the ground on which it appears The ground serves as a framework in which the figure is suspended and thereby determines the figure" It is reasonable therefore to assume that the frame of reference for figure-ground discrimination (ground) arises prior to the actual discrimination (figure and ground).

Insofar as ground perception may be presumed to be more primitive than figure perception and insofar as the child's perception of figure assumes certain of the characteristics of ground perception (for a large figure on a large ground assumes certain of the qualities of ground, since it diminishes the boundary relationship between the two which is a fundamental characteristic of figure) we may say that again child perception is seen as more primitive than that of the adult

Koffka (5b, p. 193) has stated. "If we have a small figure on a large ground it follows that the density of energy must be greater in the figure than in the ground, proportional to the ratio between the ground and figure area . . . It is clear that the smaller the area of the figured part in a constant field, the greater its relative energy density with regard to the ground part." Thus we see a tendency for the adult to perceive figure as having greater energy density than does the child. It may be that the general sequence of perceptual development is for perception of figure and ground to move from less to greater energy density, in which case child perception seems again to be more primitive than does the adult.

The results of this greater primitiveness of the child's figure perception may be seen in any task involving separation of a uniform background into two distinct qualities of figure and ground Such a task is involved in a child's jigsaw puzzle. Even if only one jigsaw piece remains to be fitted into a puzzle, the preschool child will often ignore it, and (believing it to be insoluble) will destroy the puzzle. If, having found the missing piece, his attention is distracted for a moment, he will return to the task remaining without memory of his previous behavior; and will carry out the laborious sequence of search until he has again found the piece. Having once put the correct piece into its proper place, he will often remove it, asserting that it does not belong there; and he will often attempt to force an incorrect piece into a space, despite its obvious (to an adult) incorrectness. Such behavior is explicable in terms of the incomplete separation of the qualities of figure and ground. It is possible also that much of the random trial and error behavior of the young child may be thus attributed to relatively poor figure articulation.

F. Summary and Conclusions

Following a preliminary experiment demonstrating figure-ground perceptual differences between preschool children and adults, a multiple choice test of the ability to select a choice card as most like the test card exposed was devised, with half the eight series varying choice cards in figure with ground constant, the other half of the eight series varying ground with figure constant. Twenty-three children, three years eight months to five years eight months, and 20 adults were tested. It was discovered that:

1 In the main experiment (figure variable) children tended to select a card with a large figure as most like the test card exposed. This trend was significant at the 1 per cent level of confidence. They also tended (ground variable) to select a card of strong ground density as most like the test card

exposed. This trend, however, was not significant at the 5 per cent level of confidence.

2. In the main experiment (figure variable) adults showed no significant tendency (less than 20 per cent level of confidence) to select either a large or small figure as most similar to the test card; but they tended (ground variable) to choose a card of strong density as most like the test card. This was significant at the 2 per cent level of confidence

3 The significance of these findings for supplementing the Gestalt theory of figure-ground perception is discussed

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The Journal of Genetic Psychology, 1949, 74, 325-342

BOOKS

The *Journal of Genetic Psychology*, the *Journal of General Psychology*, and the *Journal of Social Psychology*, will buy competent reviews at not less than $2 per printed page and not more than $3 per printed page, but not more than $15 00 for a single review

Conditions. Only those books that are listed below in this section are eligible for such reviews. In general, any book so listed contains one or more of the following traits. (*a*) Makes an important theoretical contribution, (*b*) consists largely of original experimental research, (*c*) has a creative or revolutionary influence in some special field or the entire field of psychology, (*d*) presents important techniques

The books are listed approximately in order of receipt, and cover a period of not more than three years A reviewer must possess the Ph D. degree or its equal in training and experience

Procedure If among the books listed below there is one that seems important to you, you are invited to write a review of that book It is not necessary to make arrangements with the Editor. Just send in your review. It does not matter if the book in question has been reviewed before

(1947)

SHERIF, M , & CANTRIL, H. The Psychology of Ego-Involvements. New York: Wiley, 1947 Pp 525

FLUGEL, J C Men and Their Motives New York International, 1947 Pp 289

ALLPORT, G. W., & POSTMAN, L The Psychology of Rumor. New York. Holt, 1947 Pp 247

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ALSCHULER, R H , & HATTWICK, B. W Painting and Personality: A Study of Young Children Chicago: Univ Chicago Press, 1947 Pp (2 vols.) 590

VARIOUS AUTHORS Army Air Forces Aviation Psychology Program Research Reports (Many volumes by various authors A review may concern only one significant volume, or may involve the entire series) Washington: U S Printing Office, 1947

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CRITICAL REVIEWS OF RECENT BOOKS

The Journal of Genetic Psychology, 1949, 74, 327-334.

(Terman, L. M., & Oden, M. H. The Gifted Child Grows Up. Stanford. Stanford Univ. Press, 1947. Pp 448.)

REVIEWED BY NATHAN ISRAELI

The *Genetic Studies of Genius* describe the mental growth and progress of a group of a thousand California gifted children. At the time that this program had been initiated, in 1921-22, their average age was 10. This book is the latest report appearing in this series. After reviewing previous work, it covers the more recent follow-up studies to 1947 when the average age of the group reached 35. This is an analysis of an important stage in the development of those gifted children. I shall confine this review to some of the major aspects of the Stanford research program.

LONG RANGE RESEARCH

This investigation is certain to continue throughout the lifetime of the gifted subjects. It may last even longer than hitherto projected. As a hint of further developments, it is well to note that the investigation has already reached the second generation. In measurement of the *IQ* of the offspring of the gifted subjects, it has been ascertained that their *IQ* has regressed half-way towards the average 100 *IQ* level from that of the gifted parents. One may be curious enough to want to extend this inquiry to the third and to succeeding generations concerning this regression and its subsequent course and also to determine whether the unusual proportion of high *IQ*'s will be maintained by future generations of gifted subjects.

Actually, psychological studies are usually short term and hardly ever long term in nature. Yet, from an informal viewpoint, long term research takes place when a new hypothesis arouses scientists to carry out various experimental studies. Such studies may lead to new points of departure which in turn open up many new avenues for research. This is also exemplified by the individual scientist who specializes in a certain field and explores diverse problems over a period of several decades.

Since this series of genetic studies of genius will extend for quite some time in the future, the blue print for the future work should be carefully designed. One also hopes that proper steps are taken to assure sufficient funds for uninterrupted progress. This program warrants continuation as it is of profound importance for science, for education, and for human welfare. It is one of the outstanding long range psychological programs of the century.

GENETIC AND OTHER STUDIES OF GENIUS

One shortcoming of this book is its discontinuity of follow up of the gifted children and its failure to relate a continuous story of their development. It is not a continuous longitudinal study. It is rather a series of cross sectional composite pictures of different stages in the development of gifted subjects. In a longitudinal study a graph would show continuous developmental curves based on frequent observations. The viewpoint of the Stanford psychologists that the genetic method "is more likely to throw light upon causal factors and shaping influences than is the method which works backward from completed career to early life" (*Vol. III*) has not been completely substantiated. In view of the difficulties in the way of an intensive series of continuous studies, the genetic approach is not self-sufficient or adequate but should be paralleled by other methodical studies of gifted persons of different age-levels in different stages of growth and achievement in various parts of this country and in other countries. In one instance, the authors compare an outstanding subgroup of the gifted persons with Rhodes scholars I feel it worth while to go further than did Dr. Aydelotte in his report on Rhodes scholars and relate the analysis to the more general study of genius. Similarly, studies should be made of various undergraduate, graduate, and post-doctoral scholars and fellows; of men and women in high ranking business, academic, and government posts, and of various types of inventive and creative persons. This calls for a comprehensive study of genius to be carried out in different research centers.

Perhaps, a study should also be made by the Stanford psychologists of fresh groups of California gifted boys and girls at least once every 10, every 20, or every 25 years. That would go far beyond reliance upon one longitudinal study of one group of subjects. Other psychologists should carry on parallel studies elsewhere Through such an extension of the Stanford genetic studies of genius to other California generations of gifted boys and girls, and to other gifted subjects elsewhere, the studies would reflect more rapidly technological improvements in psychology, and would also measure more sensitively the effects upon the growth and development of superior people and of geniuses in both constructive and adverse directions of such factors and conditions as depression, unemployment, war, inflation, home background, methods of education, and social motivation and incentives.

Each university should provide for systematic exploration and later follow-up of its own high *IQ* students. Actually, schools and universities are compiling records and statistics relating to the intelligence, personality, and educational achievements of students. There are apparently too many restrictions imposed upon educational research in the schools. Much could be done in utilization of such records for tracing the development of high *IQ's* during their school history A continuity of various civilian and military peacetime and wartime records, including those of the roster of scientists, would also provide additional material for large-scale studies of high *IQ's* and of genius.

It may be urged at this time that a research coordinating center for integration and stimulation of studies along these lines is timely now Furthermore, *UNESCO* or other agency might find it worth while to promote a world wide study—for genius is a topic of importance and interest to all nations

The Original Control Group

No report on the original non-gifted control group of boys and girls, with whom the gifted subjects had been contrasted at the beginning of these studies, appears in this book. Financial expenses involved in a follow-up of that control group or fundamental methodological reasons may account for this. The gifted subjects are compared for 1940 and for 1947 with the generality instead of the more limited original control group. No statistics for the general population are available for evaluation of the results of studies of the incidence of alcoholic habits, or of marital adjustment and happiness It may be necessary therefore to carry on with a follow-up of the non-gifted control group or of a sampling of that group Besides, concerning that group one may ask several basic questions (*a*) What is the average *IQ* of the offspring of the control group children? (*b*) What about its successes and failures? (*c*) What is the incidence of high levels of attainment and recognition?

Education for the Gifted

The authors review the academic records of the gifted subjects Their discussion is highly significant for educational administration and research They show that the gifted accelerates have progressed in later life much further than the gifted non-accelerates We learn however that many of the gifted children had been educationally retarded by three full school grades. It will be recalled that Hollingworth indicated that low *IQ*'s were frequently three grades beyond their intelligence level. What a contrast between the overacceleration of the backward and defective and the underacceleration of the superior and near-genius! Since enrichment is considered to be "a quantitative increase of work on the usual level" (p. 264), enrichment appears to be somewhat absurd. To take one instance, what is the sense of having gifted pupils read more primers rather than fewer primers than the average pupils? Enrichment which consists of work on a higher grade level is actually a form of acceleration. For enrichment to have general meaning the following basic requirements must be met: a specially trained staff, allowance of leeway to the staff and students for initiative and independent work, a constructive atmosphere, adequate quarters and supplies, and continuous enrichment throughout all school grades.

Our authors do not consider the type of education best suited for creative achievement, and in this connection the topic of originality is not prominent. There are numerous allusions to the versatility of interests and abilities of high *IQ*'s. Catharine Cox regarded versatility as a distinctive trait of very high *IQ* geniuses (*Vol. II*). In this book, it is stated that "versatility rather than one-sidedness is the rule with gifted children . . . their achievement quotients are unusually high in all their school subjects" (p. 377) and they showed "spontaneous interest in many fields" (p. 204). Versatility is of importance in a discussion of education for creative achievement; in higher education one refers now to the concept of interdisciplinary training which is the cultivation of versatility. Based on the earlier Stanford allusions to versatility of high *IQ*'s, I made the following suggestion in 1931 relative to education for superior undergraduates—in the University of Maine newspaper:

> The future of higher education of superior students may depend upon the extent that superior students are motivated to put forth effort and expend energy in proportion to their superiority. One might suggest that the superior college individuals would be divided into three or more groups Group *A* composed of those with the highest *IQ*'s, would be given the greatest amount of intellectual freedom and opportunity For them research would be the watchword. Nothing short of originality would be constantly preached to them. No one would confine his activities to only one major subject . . The university would seek to find out scientifically how to inspire Group *A*, its most superior students. Our Group *A*, would be successfully stimulated to undertake the most difficult academic tasks during their undergraduate career. . . This is what may be called the *differential plan for higher education of superior students*.

Creative Achievement and Originality

One of the crucial tasks ahead for the Stanford psychologists is the exploration and measurement of creative achievement and originality. They designed a Concept Mastery Test as a test for the quick measurement of intelligence as part of their follow-up study. What is needed is more than that—to turn it about, one must develop a Concept Discovery and Invention Test. The *CAVD* test of Thorndike similarly falls short in its failure to tap capacity for creative achievement. For one thing, the latter test is concerned with the ability to follow directions Actually, what is necessary is measurement by the authors of the ability to prescribe directions. At the higher levels of work, of considerable importance are such responsibilities as those for the initiation, direction, coordination, and execution of extensive programs which comprise many different kinds of projects and operations and the ability to set up policies ond procedures The Stanford psychologists must sooner or later measure abilities for the innovation of new concepts, shaping of new designs, and various aspects of inventiveness or other creative inclinations. As a background for such work, there are many brilliant studies and viewpoints such as those relating to incubation, intuition, rôle of complexes and emotional factors, motivation, social requirements, part-whole relationships, imagery, atmosphere effect and so on Just as Wertheimer made a brief but penetrating study of Einstein's productive thought patterns, similar studies should be made of various productive and inventive persons

Psychopathology of Genius

Terman is convincing in his demonstration of the equality or superiority of the gifted group to the generality with respect to health, height, weight, and freedom from serious defects It may be noted that the recent follow-up studies do not include medical examinations, so essential in this study, but rest upon self-ratings for health and maladjustment. Both a comparison of mortality figures with statistics for the general population in this country and a comparison of statistics for hospitalization for mental disorders based on admissions to mental hospitals in New York State show that intellectual superiority goes together with good physical and mental health With regard to this general result, in reporting upon a comparative study of the outlook upon the future of mental patients and of Scottish high *IQ*'s I indicated in 1935 that there was a similarity between the strength of drive towards future goals and objectives of manics and of high *IQ*'s but that the manics tend to "go beyond reality in widening their future possibilities beyond substantial basis and in expanding opportunities ahead without an inherent possession of high intelligence, special abilities, or the means to really function in future situations imagined by them" (*Outlook upon the Future of British Unemployed, Mental Patients, and Others*). In 1936 I concluded that the views of Lange-Eichbaum and of Kretschmer "that a psychopathic background is an essential component of genius do not hold in the least, in this experiment, for superior adolescents" (*Abnormal Personality and Time*). Terman concludes that "in our gifted group success is associated with stability rather than instability, with absence rather than presence of disturbing conflicts—in short, with well-balanced temperament and with freedom from excessive frustrations" (p. 352). He points out that some of the gifted persons are contented in their quiet pursuits and that on the whole the gifted persons are maritally happy and well adjusted. That does not take into consideration the incidence of remorse among those who are not functioning at their highest levels.

The problem of the relationship between genius and insanity will prove much more difficult and perhaps somewhat elusive.

INDIVIDUAL DIFFERENCES AND CASE STUDIES

Too little attention is given here to individual cases—with certain exceptions In later reports, information should be presented for individual differences with illustrative case studies. It is essential to include a comprehensive account of the test and other information concerning the mental growth and life history of individual gifted persons. These studies should include objective biographic information for specific individuals. It may be difficult to determine to what extent to make an individual coverage. However, such information would prove invaluable in discussion of such problems as the pre-psychotic history of all persons hospitalized at one time or another for mental disorders. It would be helpful in making a dynamic psychological analysis of individuals in this group taking into consideration factors involved in success or in failure, and in making a social psychological analysis of the interpersonal relationships of such individuals in groups with which they are identified

Reports should be maintained for each person showing changes from one occupational level to another and changes from one occupation to another Such records enable one to follow the occupational growth of the gifted person in terms of aims and drives, mastery of methods and techniques, opportunities for original work, and administrative and executive responsibilities.

AUTOBIOGRAPHIC METHOD

The Stanford studies would be enhanced by use of the autobiographic method. In a study of Scottish superiors already referred to above I used the autobiographic method with a projection towards the future This may be termed an autobiographic projective method It has considerable promise for studies of personality and of dynamic aspects of social adjustments of individual. The Stanford studies have been restricted as the staff did not want to make the subjects overconscious of being under observation as superior individuals The staff limited the number of follow-up contacts with them and also avoided the element of guidance of their development. Incidentally, that introduces another problem. comparison of the development of high *IQ*'s with and without guidance. Despite those restrictions imposed by the staff, considerable data of importance maybe secured through application of the autobiographic method as when the subjects tell the story of their development and experiences.

Just as the literary fragments of gifted children were used in rating those children for literary promise, various personal documents (Allport) should be used as sources of information. Another point in this connection is the likelihood that some of these subjects will write their autobiographies for publication or may be the subjects of biographic sketches by others If the policy of anonymity should continue, those autobiographies and biographies will not be definitely and clearly identified—and the outside world will lose by that much a more intimate description of the attainments and struggles of the individuals concerned. In the same sense, their symphonies, books, dramas will be unknown—no one will definitely know about their inventions and discoveries except in a general sense This question of personal identification is a difficult one This is a question perhaps for the next century.

ACHIEVEMENTS AND ATTAINMENTS

The time is drawing near when the most important issue of this study—the relationship of high *IQ* in early childhood to the accomplishments of genius—can be put to the test The original criterion in selection of the gifted boys and girls for this experimental group was an *IQ* of 140 or higher. Terman believes that the most important result of this study is the demonstration of the intrinsic value of measurement of levels of intellectual capacity The research program is now heading for the measurement of the higher levels of productivity and attainment

In their brief discussion of eminence and genius here, the authors express dissatisfaction with the conventional criteria of eminence. They concede that the "chances that a single one of our gifted group will ever be included in a future list of the thousand most illustrious men and women of all time must be small indeed" (p. 371)—of course, in the long run, the group represents only a limited sampling in a restricted geographic area. The most difficult part of this program lies in the future. Measurement of the ranks of near-genius will be very controversial unless good criteria can be devised along tentative lines.

The authors imply that technical specialization circumscribes the breadth of operations of brilliant persons today. "Conceivably, if Darwin were living today he might be just another high-class mathematician, astronomer, or nuclear physicist" (p. 370). Today there is an increased demand in industry, education, and the government for generalists and coordinators to integrate and combine the work of specialists at various levels of specialization —and also for specialists to apply their basic techniques and methods to unrelated fields.

The genetic studies of genius are pilot research projects which have already accomplished much. The most difficult problems are yet to come As suggested above, those studies can be broadened both by the Stanford psychologists and by experimentation all along the line concerning the attainments of scientists, educators, artists, inventors, statesmen, and others. Galton's interest in men of genius carried over to eugenics. Similarly, the work of Terman is going to have many consequences. The world knows little as yet as to how to manage the education of its gifted persons. Professor Terman devoted himself to a scientific inquiry into the psychological development of men of genius. He has cleared the atmosphere of false beliefs concerning precocious children, prodigies, and men of genius. He is to be highly commended for his excellent direction of this long range program and for his keen interests in various aspects of the genetic psychology of genius.

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The Journal of Genetic Psychology, 1949, **74**, 335-339.

(*Cameron, N. The Psychology of Behavior Disorders. Boston. Houghton Mifflin, 1947. Pp 622.*)

Reviewed By P. E. Lichtenstein

The publication of Dr. Cameron's book marks the emergence for the first time in comprehensive and consistent form of a thoroughly behavioral treatment of psychopathology. As such Cameron's work departs radically from traditional textbooks of abnormal psychology which frequently include such miscellaneous topics as the statistics of mental disorder, heredity, neurology, endocrinology, feeblemindedness, receptor and effector defects, sleep and dreams, and bits of a watered-down psychiatry. The facts brought together in such texts are frequently interesting and important but often lack the least semblance of unification under a theoretical point of view. Some authors who show definite leanings toward an organic viewpoint, for example, may sprinkle their writing with liberal doses of psychoanalysis.

Cameron has not attempted to include an exhaustive catalogue of the behavior disorders, and the reader, therefore, will find much of the specialized terminology of abnormal psychology lacking From the standpoint of the student such omission will probably enhance rather than hinder effective understanding The author has succeeded in writing a systematic and coherent account of psychopathology which contrasts sharply with most current writing in this area. Unfortunately the eclectic textbooks, which may be used successfully to teach terminology, symptomatology, and nosology, are likely to produce considerable confusion in the thinking of the beginning student.

In a sense the textbooks have merely reflected the theoretical chaos of psychopathology From its inception psychopathology has never had a consistent, naturalistic, and workable theory. The somatogenic hypothesis, developed early in the scientific period, has not, in spite of some successes, lived up to its early promise. Today the theory stands as chiefly programmatic, after years of painstaking research there are few clear indications that the neuroses and the functional psychoses are simply or even predominantly organic disturbances Indeed it was perhaps the failure of the organic viewpoint which more than anything else paved the way for current psychogenic theories of mental disorder. The researches of Charcot, Janet, Liébault, and Freud certainly uncovered many facts which lent themselves readily to mentalistic interpretations Since even the most ardent supporter of the somatogenic theory was often willing to accept the existence of an epiphenomenal psyche, he could more or less easily accept such theorizing. Even today, despite an apparent basic cleavage, we find that psychogenic and somatogenic theories may coexist. To some extent this coexistence of incompatible theories is traceable to the distinction between the organic and the functional disorders. Thus, while all disorders may be thought of as ultimately organic, it may be profitable at present to treat the so-called functional disorders in the terms of an epiphenomenal psyche. This peculiar doctrine is, of course, thoroughly grounded in a persistent mind-body dualism While the psychobiology of Adolph Meyer never succeeded in overcoming the dualism of mind and body, simply offering a sort of double-aspect solution, still Meyer did succeed in treating the organism holistically and in shifting the emphasis from isolated biological or mental events to the person in trouble.

With Cameron's work psychopathology has entered a new phase in which dualism is completely extruded, and all of the activities of persons, including such recondite actions as thinking and imagining, are viewed as neutral and natural behavioral events. Behavior under such a view requires neither reduction to the physiological functioning of the organism nor translation into the terms of a disembodied psyche. Rather, behavior is to be described directly in its own terms, that is, in terms constructed on the basis of observed events and not simply derived from traditional assumptions. The author's point of view is broadly biosocial treating complex individual behavior as having emerged through the interactions of persons with objects in the environment and involving more particularly other persons.

The line of development in American thought which underlies Cameron's work cannot be characterized in a word. The broad philosophy represented by the writings of James, Dewey, and Mead might be called naturalistic, empirical, pragmatic, and humanistic although these adjectives taken alone or together fail to convey the full meaning of this philosophical movement. James reflected in his *Principles* the dominant dualistic trend of that period. Later, however, in his more philosophical writings James achieved more direct behavioral reports and came to question the advisability of insisting upon the existence of consciousness. Dewey's later development of the concept of transaction made possible a truly biosocial psychology and thereby broadened the base of psychological science considerably. With Mead, the emphasis shifted more to the social process, language, and rôle-taking, concepts which Cameron has developed to great advantage. In highlighting the work of James, Dewey, and Mead we merely wish to indicate the slow development of a view which places its chief emphasis upon direct observation and straightforward report of behavior as a natural event describable in its own terms.

Through the years there have been a few indications of a trend toward a more objective psychopathology. For example, Kantor, writing in 1926 in the second volume of his *Principles of Psychology,* said. "The study of abnormalities from an objective psychological standpoint may be expected to yield in the near future descriptive terms derived from the observed behavior conditions rather than from neurological (medical) or mentalistic (psychological) tradition." It is interesting to compare the content of the above quotation with that of the following statement from Cameron's Preface: "It (the title of the book) follows a prediction made five years ago that psychopathology—or behavior pathology as I propose to call it—will shift progressively in emphasis, from speculations about a psyche in a somatic container to the study of the operations of human organisms in a social field" On several occasions Cameron makes statements suggestive of an interbehavioral or organismic approach to psychology In discussing rôle-taking, for example, Cameron says. "These rôles are acquired through the child's interbehavior with his parents, his siblings, and the other persons making up his human environment, and they are defined in terms of this interbehavior." While it is abundantly clear from numerous passages that Cameron is writing the general framework of field theory, it is also evident that he is treating the behavioral field objectively and not in the mentalistic fashion of topological and Gestalt psychologists.

The reader who is partial to psychoanalysis, constitutional theories, or biological reductionism may find Cameron's work far from satisfactory. The author's criticisms of psychoanalysis are particularly severe although the great significance of data uncovered by the Freudians is clearly recognized and due credit is given.

There seems to be a tendency, once one has developed facility in the use of the constructs of a particular system, to feel that descriptions couched in such terms have greater explanatory value than those of some other system Such feelings are undoubtedly just as characteristic of the behaviorist or Gestaltist as they are of the psychoanalyst. To admit this fact, however, does not mean that there exists no more than a subjective basis for the acceptance or rejection of the constructs of a scientific theory. It is a common contention that constructs always transcend observed data and that, therefore, as a construct the superego is not essentially different from the gene. If the superego has not been observed but is simply inferred, it is said that the same holds for the gene. Recently, however, the gene has reportedly been observed. Whether or not the spots seen under the electron microscope actually are genes, in principle, at least, the gene is observable. This fact serves clearly to differentiate the gene as a scientific construct from the superego which is by definition unobservable. Of course, one may choose to translate, reevaluate, and redefine psychoanalytic terms, thereby making them possibly more objective. On the other hand, one may ignore psychoanalytic constructions and erect behavioral constructs directly on the basis of verifiable observations. The latter approach is the one preferred by Cameron, and it is an eminently defensible one. Anyone who undertakes the translation of psychoanalytic constructs cannot easily rid them of their mentalistic connotations and may simply content himself with anchoring them in the biological functions of the organism Myths are perhaps better avoided in science by abjuring them altogether than by attempting to make them slightly more palatable.

Only in a single chapter on cerebral incompetence and behavior pathology does Cameron treat at all extensively the biological factors in mental disorder. To the reader who may be tempted to ask why the author fails to treat in any detail the contributions from such fields as heredity and endocrinology the answer is simply that Cameron's primary interest lies not in tissue pathology but in behavior pathology. To assert that such a distinction is not a real one is to deny the validity of the author's contribution. Furthermore, the failure to differentiate between tissue pathology and behavior pathology is to endow tissues with functions they have never been shown to possess. To assert that a basis for the functional psychoses will someday be found in tissue pathology is simply to state a faith. Furthermore, as the author indicates, brain pathology need not mean inevitable behavior pathology. Cameron says: "Significant is the realization that many behavior disorders which used to be ascribed unhesitatingly to cerebral histopathology have no such basis. They represent the reactions of sick or injured persons to the fact or the consequences of being sick or injured, and differ in no fundamental way from reactions to illness or accident involving other parts of the body" The author flatly rejects the interpretation of schizophrenia as brain disease and then proceeds to demonstrate the effectiveness of the biosocial approach. It is the author's success in handling the data of behavior pathology which renders the faith of the somatogenist quite superfluous and meaningless.

A bisocial theory of psychopathology does not deny the possible rôle of hereditary factors in schizophrenia nor of endocrine factors in manic-depressive psychosis Rather it holds that such biological conditions are only a few among many factors to be taken into account in giving a workable description of the behavior disorders. Biological conditions, then, are not to be regarded as simple or universal causes but rather as participating factors in more comprehensive events. Concentration upon brain function, biochemical data, drug effects, and the electrical activity of muscle and nerve to the exclusion of behavioral facts described in terms of all of their observable conditions (including the social) has not proved profitable in a practical way nor has it been of any great heuristic value.

The author's descriptions tend to be gross and comprehensive rather than fully analytical While his treatment covering broad segments of behavior is exhaustive and extremely informative, the concepts used are geared to a general observational level Nowhere is there any attempt to articulate the writing closely with current learning theory In the opinion of the reviewer this constitutes no serious flaw, and any attempt to make a wholesale application of constructs derived largely from animal experimentation might well be premature On the other hand, the gap separating psychopathology from learning theory should not be allowed to remain for long. Bridging this gap will become perhaps the major task of experimental psychopathology. While a more thorough grounding in learning theory might serve to reinforce Cameron's descriptions, it cannot be denied that many of the author's original conceptions should provide the experimentalist with a mine of suggestive hypotheses.

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BOOKS RECENTLY RECEIVED

(There will always be two pages of book titles, listed in the order of receipt, i.e., the most recently received books will be found at the end of the list)

STAGNER, R. Psychology of Personality. New York· McGraw-Hill, 1948 Pp 485

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